United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Missouri Agricultural
Experiment Station

Soil Survey of Benton County, Missouri

How To Use This Soil Survey

General Soil Map

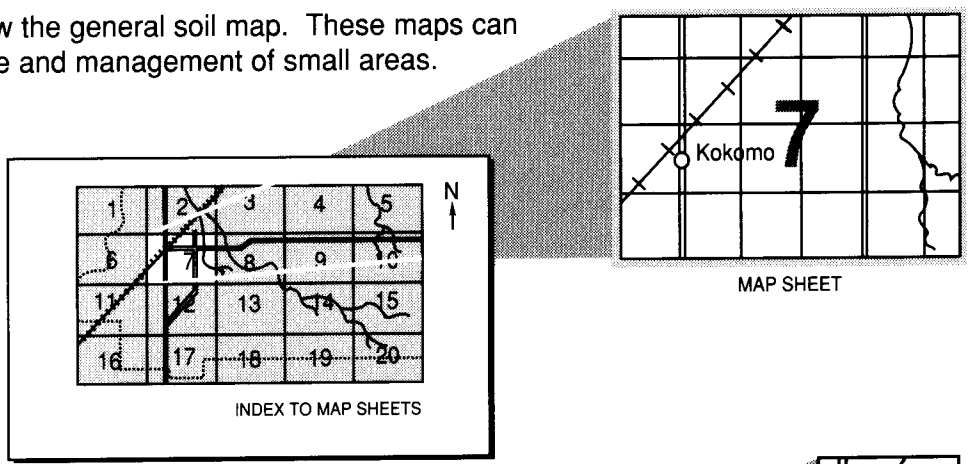
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

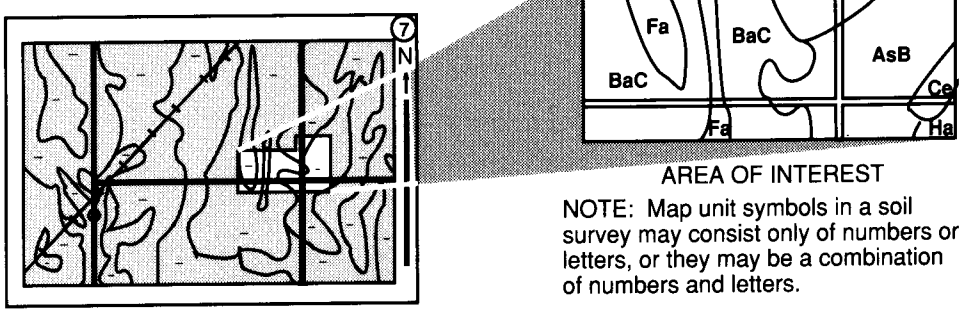
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1985. Soil names and descriptions were approved in 1986. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. The Missouri Department of Natural Resources provided a soil scientist to assist in the fieldwork. The County Commission, through the Benton County Soil and Water Conservation District, provided funds for a soil scientist to assist in the fieldwork. The survey is part of the technical assistance furnished to the Benton County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Pastured area of a Bardley soil in the Goss-Bardley-Doniphan association.

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Foreword

This soil survey contains information that can be used in land-planning programs in Benton County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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State Conservationist
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Soil Survey of Benton County, Missouri

By George T. Simmons, Soil Conservation Service

Fieldwork by George T. Simmons, Soil Conservation Service; Mark Emerson and David Goggins, Missouri Department of Natural Resources; and Kenneth L. Gregg and Dudley Kaiser, Benton County Soil and Water Conservation District

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Missouri Agricultural Experiment Station

BENTON COUNTY is in the west-central part of Missouri (fig. 1). The county has a total area of about 481,382 acres, or 752 square miles, which includes about 36,972 acres of water. Warsaw, the county seat, is in the central part of the county.

Most of Benton County is in the Ozark Highland and Ozark Borderland land resource areas of the East and Central General Farming and Forest Region of the United States. A small part of the northwestern corner is in the Cherokee Prairies land resource area of the Central Feed Grains and Livestock Region *(17)*.

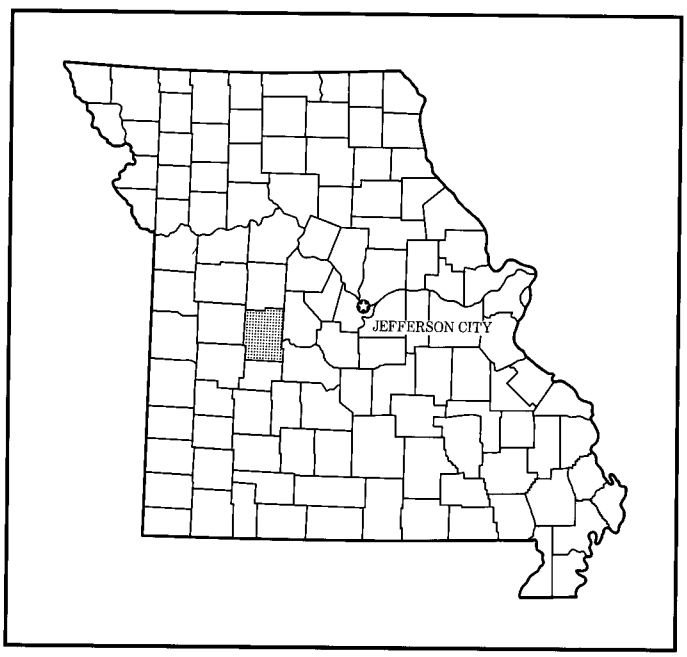

Figure 1.—Location of Benton County in Missouri.

General Nature of the County

This section gives general information concerning the county. It describes climate; physiography, geology, and natural resources; relief and drainage; settlement and population; and farming.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Warsaw in the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 34 degrees F, and the average daily minimum temperature is 23 degrees. The lowest temperature on record, which occurred at Warsaw on February 2, 1951, is -23 degrees. In summer the average temperature is 77 degrees, and the average daily maximum temperature

is 89 degrees. The highest recorded temperature, which occurred on July 14, 1954, is 118 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 40.53 inches. Of this, 26 inches, or about 65 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 20 inches. The heaviest 1-day rainfall during the period of record was 4.23 inches at Warsaw on May 28, 1964. Thunderstorms occur on about 57 days each year.

The average seasonal snowfall is 18 inches. The greatest snow depth at any one time during the period of record was 12 inches. On the average, 14 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 13 miles per hour, in spring.

Physiography, Geology, and Natural Resources

Three physiographic provinces are evident in Benton County. They are the Ozark Plateau, the Springfield Plateau, and the Western Plains. The undulating to very hilly Ozark Plateau region covers the eastern part of the county. It is characterized by dissection and stream entrenchment and is underlain by Ordovician-aged rocks. The mainly undulating to very hilly Springfield Plateau is in the southwestern part of the county. It is separated from the Ozark Plateau by the Eureka Springs Escarpment, which thins out and narrows directly north of Lincoln *(6)*. The Springfield Plateau is dissected by the Osage, Grand, and Pomme de Terre Rivers and is underlain by Mississippian-aged rocks. The Western Plains region is the easternmost part of the Great Plains of the United States. This nearly level and undulating region is in the northwestern part of the county. It is underlain by Pennsylvanian-aged rocks. Bedrock is at varying depths in this region and consists of sedimentary rock, such as limestone, dolomite, sandstone, and shale *(11)*.

The youngest rock formations in the survey area underlie the Barco, Bolivar, and Deepwater soils. The formations are comparatively thin and are exposed in less than 2 percent of the survey area. They are of Pennsylvanian age. They are part of the Cherokee Group, a coarse grained to fine grained sandstone that has some conglomerate at the base *(3)*. This sandstone is typical of the Warner Formation.

Cambrian-aged rock, which includes the oldest formation, is not exposed in the survey area. Rocks of Ordivician age overlie the Cambrian rock. The predominant formations exposed in the survey area are the Gasconade, Roubidoux, and Jefferson City Formations. They are very similar to one another in lithology and are predominantly cherty dolomite. The Roubidoux Formation includes lenses and local beds of sandstone. It is an important source of water throughout the northwestern part of the survey area.

Between the Pennsylvanian and Ordovician rocks is the Mississippian-aged rock. Formations in the Mississippian rock are predominantly cherty limestone. The chert content ranges from minor amounts in the Burlington and Warsaw Formations to abundant amounts in the Pierson and Sedalia Formations. The Burlington Formation crops out extensively in many areas of the southwestern part of the county.

Unconsolidated surficial deposits include residuum, loess, colluvium, and alluvium. Soil, a very important natural resource, formed in these deposits. Residuum and colluvium are dominant in all areas of the county, except for some upland areas that have a loess cap or alluvium on the flood plains.

Water for domestic use on farms is provided by streams, lakes, and ponds. Ground water from springs sustains the flow of perennial streams. Deep wells supply water to Cole Camp, Ionia, Lincoln, and Warsaw. Adequate quantities of water of good quality for home and farm use can be obtained from the Roubidoux Formation. Wells that tap this formation can produce from 10 to 30 gallons per minute in the eastern part of the county and from 15 to 85 gallons per minute in the western part. Larger yields can be produced by drilling to deeper aquifers, such as the Gasconade Dolomite, the Gunter member of the Gasconade Formation, or the Eminence or Potosi Dolomite *(4)*. Some artesian wells are in the eastern part of the county.

Relief and Drainage

Most of the county is in the early stage of the present erosion cycle. Surface features are mainly the result of the gully type of water erosion. The landscape configurations differ from one another according to geologic structure and the relative resistance of the bedrock to chemical and physical weathering.

The tilt of the bedrock is to the northwest. The general slope of the land is to the west. Elevation ranges from about 659 feet at the normal water level of the Lake of the Ozarks to 1,150 feet at the highest point in the county, which is southeast of Cole Camp. The lowest point is in the east-central part of the county, at the bottom of the Osage River.

Most of the survey area is undulating to rolling. Undulating slopes are extensive on the primary divides separating the watersheds of major streams. The uplands between the larger streams are generally undulating to rolling. Some relatively large areas of nearly level uplands are on top of the broad divide that separates the basins of the Osage and Lamine Rivers, in the northern part of the county. Other nearly level or undulating areas are the flood plains and terraces along the major streams. Most of the hilly or very hilly and broken areas are adjacent to flood plains, and some of these have precipitous, rock-scarped edges.

Most deep, well drained soils on uplands in the county formed in thick, red, clayey, permeable cherty limestone residuum. A network of solution channels formed in the bedrock. The bedrock surface is unevenly dissolved, leaving underground pinnacles 5 to 15 feet high in many places. In places, caves have formed and sinkholes have developed on the land surface.

Water easily moves downward and laterally through the well drained soils, the permeable residuum, or the cracks and solution channels in the bedrock. Much of the rainwater becomes part of the underground water supply. Some water emerges at a lower level as springs and enters the surface drainage system *(12)*. In places small streams enter underground channels and then resurface a considerable distance downstream.

This county lies primarily in drainage basins of the Osage and Pomme de Terre Rivers. The Pomme de Terre River flows northward and intersects the Osage River near the west-central part of the county. Except for a small area in the north-central part, the remainder of the county is drained by the Osage River or its tributaries. Tributaries of the Blackwater and Lamine Rivers drain the northern part of the county *(12)*.

Settlement and Population

The earliest human habitation in the survey area was probably about 10,500 years ago. Members of a hunter-gatherer culture occupied the southern part of the survey area. They depended on deer and small game from the forests and on fish, turtles, and shellfish from the rivers for subsistence. Primitive farming groups appeared about 1,500 years ago; these people were probably the ancestors of the Osage Indians, who inhabited the middle reaches of the Osage River *(19)*.

Benton County was originally a part of Howard County, which made up much of the central part of Missouri. Benton County was organized in 1835, and Warsaw was platted and named the county seat in 1838 *(5)*.

The early settlements were established along the Osage, Grand, and Pomme de Terre Rivers and along the old military road that ran from Palmyra through Boonville, Warsaw, and Springfield to Fort Smith, Arkansas *(5)*. By 1840, settlers began to locate on the prairies, and by 1869, settlement was almost continuous from the Osage River to Flat Creek *(5)*. Land speculation in 1839 and 1840 and in the period 1856 to 1858 increased the population of the county considerably. In 1835, the population was estimated at between 400 and 600 *(5)*. The population continued to increase until about 1920. People began to migrate from rural areas to the cities, and the population decreased until after 1950, when many people built recreation and summer homes along the Lake of the Ozarks. Many of these residences became retirement homes, and now many people live there on a year-round basis. Land speculators are subdividing several large tracts in the county. This activity will increase the population.

Farming

Early settlers lived in forested areas near perennial streams, where game, water, and fish were plentiful. Timber was available for the construction of shelters and for fuel and fences. The open range, with an abundance of tall prairie grasses and forest mast, provided food for cattle, work animals, and hogs. Small fields on stream terraces and bottom land were fenced and used for cultivated crops. Corn, winter wheat, tobacco, flax, and hemp were grown.

From 1834 to the end of the Civil War, most of the surplus livestock was sold to buyers settling in areas

south and west of Benton County and to Civil War armies occupying the area. Also during this period, the size and quality of the open range were reduced to a marked degree by rapid settlement, fencing, cultivation, and overgrazing. All of the staple crops, including corn and other feed grains, were limited to local consumption because there were no markets or means of transportation.

In the 1880's, a railroad was built across the northern part of the county. A spur connected Sedalia to Warsaw. After the advent of the railroad, the emphasis in farming was on crops, livestock, and livestock products for market. Corn and wheat were the chief crops. Field crop production was concentrated on the prairie uplands, bottom land along rivers, and terraces. The acreage planted to corn for cornmeal and for livestock feed exceeded that used for other crops. Wheat became an important crop. For many years it was the principal cash crop. By about 1900, as much as one-third of the survey area was used for corn or wheat. Other grain and forage crops were oats, barley, rye, sorghum, and a wide variety of grasses and legumes. As the amount of open range available for livestock production decreased, the acreage used for crops was greatly increased.

Cattle, horses, mules, hogs, and poultry were raised in all parts of the county. The demand for sheep decreased when home-spun wool was no longer used. The general farmer kept beef and milk cows for added income. On many farms hogs were fattened and sold. Poultry husbandry also became a profitable enterprise. Surplus cattle, horses, and mules were in demand.

General farming was considered a desirable and secure form of agriculture. Compared to other kinds of farming, it required more intensive cultivation of the land; better livestock husbandry; more tools, equipment, and labor; and better management. These requirements led to a larger number of smaller farms, high land values, a prosperous economy, and rapid agricultural growth. General farming peaked in 1900 but retained its position of importance until 1940.

Because of favorable natural conditions and high prices for dairy products, many farmers turned to commercial dairy farming, which was introduced in the county after the railroads became operational. An abundance of good-quality grasses and legumes, a long grazing season, and the minimal need for shelter helped to make the dairy industry important. The production of sorghum and corn silage and the increased use of alfalfa or other legumes for hay increased the volume and quality of dairy cattle feed, reduced feed costs, and increased profits. During World War II, the commercial dairy farm replaced the general farm as the leading agricultural enterprise.

Since World War II, many farmers have shifted to raising livestock, primarily beef cattle. More and larger beef cattle enterprises are being developed. Beef and dairy cattle enterprises provide the major share of the farm income in the county. Beef and grade-A milk are the leading farm products. Some farmers specialize in feeder pig production and swine finishing. Some specialize in the production of turkeys, eggs, and broilers.

In 1982, the number of cattle and calves in the county was 46,184. Of this number, 19,314 were beef cattle and 2,760 were milk cows. The major crops were corn, winter wheat, sorghum, and soybeans. Forage crops are grown on nearly all kinds of land, from small forest glades to large upland ridges. These crops include grasses, legumes, small grain, and forage sorghum. All of the forage and most of the corn and grain sorghum are fed to local livestock. Soybeans and wheat are sold for cash.

Farmland made up about 57 percent of the county in 1982 *(18)*. The number of farms was 988, and the average farm size was 277 acres.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables

the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so

complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of soils in this survey do not fully agree with those in surveys of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas it is more feasible to combine small acreages of similar soils that respond to use and management in much the same way than it is to map these soils separately and give them different names.

Soil Descriptions

1. Hartwell-Barden Association

Deep, nearly level to gently sloping, somewhat poorly drained and moderately well drained soils; on uplands

This association is on the tops and sides of ridges in the uplands. Slopes range from 0 to 5 percent.

This association makes up about 9 percent of the county. It is about 52 percent Hartwell soils, 33 percent Barden soils, and 15 percent minor soils (fig. 2).

The Hartwell soils are on the tops and sides of broad ridges. They are nearly level to gently sloping and are somewhat poorly drained. Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick or silty clay loam about 5 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is about 21 inches thick. The upper part is very dark grayish brown, mottled clay. The next part is grayish brown, mottled silty clay. The lower part is grayish brown, mottled silty clay loam. The substratum to a depth of 60 inches or more is olive gray and gray, mottled silty clay loam.

The Barden soils are on the sides and tops of narrow ridges. They are very gently sloping and gently sloping and are moderately well drained. Typically, the surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown, mottled silty clay loam. The next part is dark grayish brown, mottled silty clay and silty clay loam. The lower part is dark brown, mottled silty clay loam. The substratum to a depth of 60 inches or more is light yellowish brown, mottled silty clay loam.

The minor soils are Barco, Bolivar, Deepwater, Moniteau, Quarles, and Verdigris soils. The moderately deep, well drained Barco and Bolivar soils are on the lower side slopes and on ridgetops. Deepwater and Verdigris soils have less clay than the Hartwell and Barden soils. Deepwater soils are on the lower side slopes, and Verdigris soils are on flood plains. The poorly drained Moniteau and Quarles soils are on stream terraces.

The farms in areas of this association are large. About 70 percent of the association is used for small grain or row crops. The rest is used mainly for grasses and legumes for pasture or hay. Winter wheat is harvested in June and July. Many areas are planted to soybeans after the wheat is harvested. Winter wheat, corn, soybeans, and most of the grain sorghum are sold for cash. The forage and some of the grain are fed to beef cattle and other livestock.

The soils in this association are well suited to small grain, corn, soybeans, and grasses and legumes. Under

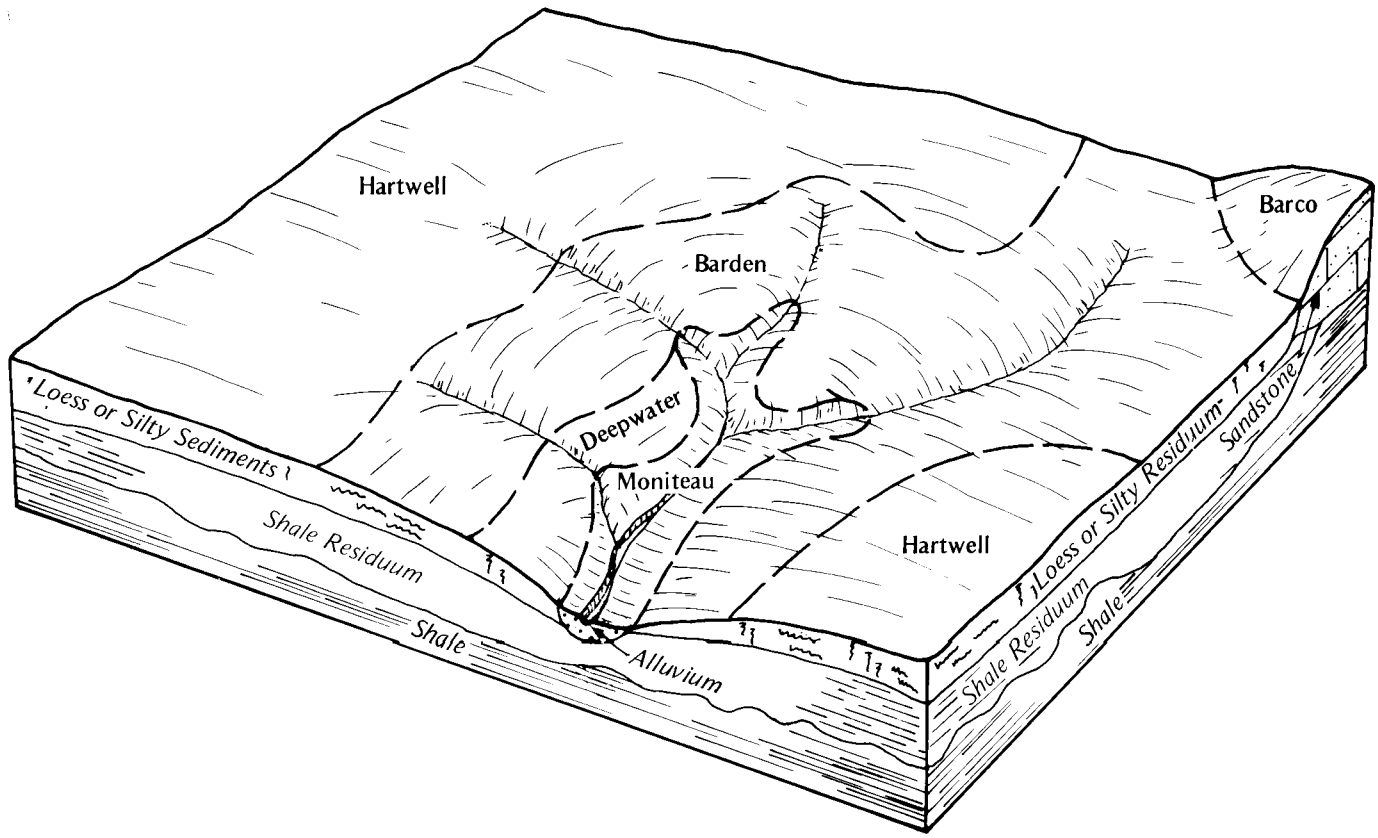

Figure 2.—Typical pattern of soils and parent material in the Hartwell-Barden association.

highly specialized management, row crops can be grown year after year. The soils are well suited to irrigated crops, especially high-value crops, but an inadequate supply of water limits the acreage that can be irrigated.

Winter wheat, soybeans, grain sorghum, most grasses, and legumes grow well on the soils in this association. Most of the soils have a moderate available water capacity and a perched high water table during winter and spring months. The main management concern is controlling erosion, especially if row crops are grown on the soils that have long, gradual slopes or shorter slopes of more than 2 percent. Improving surface drainage in the nearly level areas also is a major management concern.

The major soils generally are suited to sanitary facilities and building site development. The main management concerns are wetness, a high shrink-swell potential, and restricted permeability.

2. Eldon-Creldon-Barden Association

Deep, very gently sloping to strongly sloping, well drained and moderately well drained soils; on uplands

This association is on broad upland ridges and narrow flood plains. Slopes range from 1 to 14 percent.

This association makes up about 10 percent of the county. It is about 38 percent Eldon soils, 16 percent Creldon soils, 10 percent Barden soils, and 36 percent minor soils (fig. 3).

The Eldon soils are on the convex tops and sides of ridges. They are gently sloping to strongly sloping and are well drained. Typically, the surface layer is very dark grayish brown cherty silt loam about 10 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is reddish brown very cherty silty clay loam and red very cherty silty clay. The lower part is red clay.

The Creldon soils are on the tops and sides of

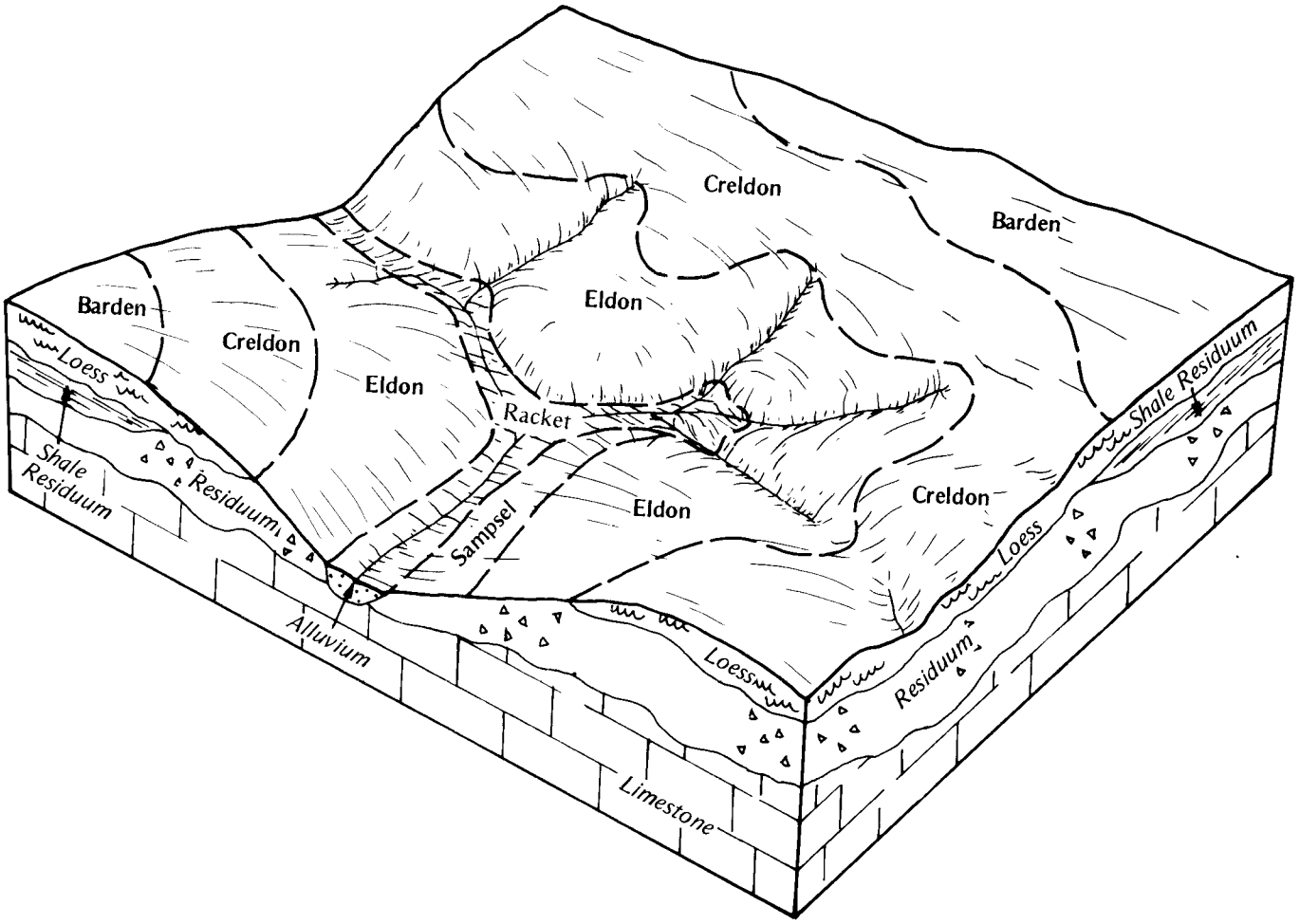

Figure 3.—Typical pattern of soils and parent material in the Eldon-Creldon-Barden association.

ridges. They are gently sloping and moderately sloping and are moderately well drained. Typically, the surface layer is dark brown silt loam about 14 inches thick. The subsoil extends to a depth of 60 inches or more. In sequence downward, it is yellowish brown, mottled silty clay loam; mottled grayish brown, yellowish brown, and dark reddish brown silty clay loam; a fragipan of pale brown, mottled, brittle very cherty silt loam; strong brown, mottled very cherty clay; and red extremely cherty clay.

The Barden soils are on ridgetops. They are very gently sloping and gently sloping and are moderately well drained. Typically, the surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown, mottled silty clay loam. The next part is dark grayish brown, mottled silty clay and silty clay loam. The lower part is dark brown, mottled silty clay loam. The substratum to a depth of 60 inches is light yellowish brown, mottled silty clay loam.

The minor soils are Doniphan, Racket, and Sampsel soils. Doniphan soils are on ridgetops and side slopes. They are lighter colored than the major soils. The nearly level Racket soils are on flood plains. They are more silty than the major soils. The poorly drained Sampsel soils are on foot slopes and at the head of drainageways.

About 85 percent of this association is used for grasses and legumes. About 10 percent is used for small grain and row crops, and 5 percent is second-growth woodland. The forage crops and most of the grain crops are fed to beef and dairy cattle. Winter wheat and soybeans are sold for cash. The association is well suited to grasses, legumes, and small grain in all

areas, except for a few stony areas and scattered small areas of rock outcrop. The very gently sloping and gently sloping Barden and Creldon soils are well suited to cultivated crops.

Forage and grain crops grow well on Barden and Creldon soils and on the minor Racket and Sampsel soils. Most of the soils have a high or moderate available water capacity. The Eldon soils and some minor soils on narrow flood plains, however, are cherty and have a low or moderate available water capacity. The Creldon soils have a dense fragipan at a depth of 18 to 36 inches. The fragipan limits the root zone. A high water table is perched above the fragipan in most winter and spring months. The main management concerns are reducing summer droughtiness and controlling erosion, especially if row crops are grown on soils that have slopes of more than 2 percent.

The major soils are suited to sanitary facilities and building site development. The main management concerns are wetness and the shrink-swell potential.

3. Goss-Bardley-Doniphan Association

Moderately deep and deep, gently sloping to very steep, well drained soils; on uplands

This association is on narrow ridges in the uplands. The landscape is highly dissected by V-shaped drainageways and narrow flood plains. Slopes range from 3 to 45 percent.

This association makes up about 40 percent of the county. It is about 24 percent Goss soils, 22 percent Bardley soils, 18 percent Doniphan soils, and 36 percent minor soils (fig. 4).

The Goss soils are on the lower side slopes. They are deep and are moderately steep to very steep. Typically, the surface layer is dark brown cherty silt loam about 5 inches thick. The subsurface layer is yellowish brown very cherty silt loam about 8 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is strong brown extremely cherty silty clay loam. The next part is red very cherty silty clay. The lower part is red very cherty clay.

The Bardley soils are on the tops and sides of ridges. They are moderately deep and are gently sloping to steep. Typically, the surface layer is very dark grayish brown very cherty silt loam about 4 inches thick or dark brown cherty silt loam about 7 inches thick. The subsurface layer is yellowish brown very cherty silt loam about 4 inches thick. The subsoil is about 22 inches thick. It is red and yellowish brown cherty silty clay loam in the upper part and red, yellowish red, and pale yellow clay and gravelly clay in the lower part. Dolomite or limestone bedrock is at a depth of about 30 inches.

The Doniphan soils are on the tops and sides of ridges. They are deep and are gently sloping to strongly sloping. Typically, the surface layer is very dark grayish brown cherty silt loam about 3 inches thick. The subsurface layer is brown cherty silt loam about 5 inches thick. The subsoil extends to a depth of 60 inches or more. It is yellowish red cherty clay in the upper part and red and dark red, mottled clay in the lower part.

The minor soils are Claiborne, Gasconade, McGirk, Racket, and Union soils. The deep, well drained Claiborne soils are on foot slopes. They are silty throughout. The shallow, somewhat excessively drained Gasconade soils are on the lower convex side slopes. The deep, poorly drained McGirk soils are at the head of drainageways. The nearly level Racket soils are on narrow flood plains. The deep, moderately well drained Union soils are on the tops of the broader ridges. They have a fragipan.

Nearly all areas of this association are used for grasses and legumes or for trees. The acreage used for pasture is about the same as that used for woodland. A very small acreage is used for small grain or row crops. The forage and grain are fed to beef and dairy cattle. Most mature trees are harvested and sold as logs, firewood, and other wood products.

Most of the soils in this association are well suited to grasses and legumes. Most grasses and legumes grow well. Cultivated crops and trees grow well on the soils that are on terraces and flood plains. Controlled grazing is needed in pastured areas.

The suitability of this association for woodland is fair or good. Trees grow well on the strongly sloping to steep soils on the north- and east-facing slopes in the uplands. The major soils have a low or moderate available water capacity. The main management concerns are droughtiness and the windthrow hazard.

The major soils are suited to sanitary facilities and building site development. The main management concerns are the depth to bedrock, restricted permeability, the shrink-swell potential, seepage, and the slope.

4. Bardley-Gasconade-Goss Association

Shallow to deep, gently sloping to very steep, well drained and somewhat excessively drained soils; on uplands

This association is on upland ridges dissected by narrow flood plains. In places rock escarpments are at

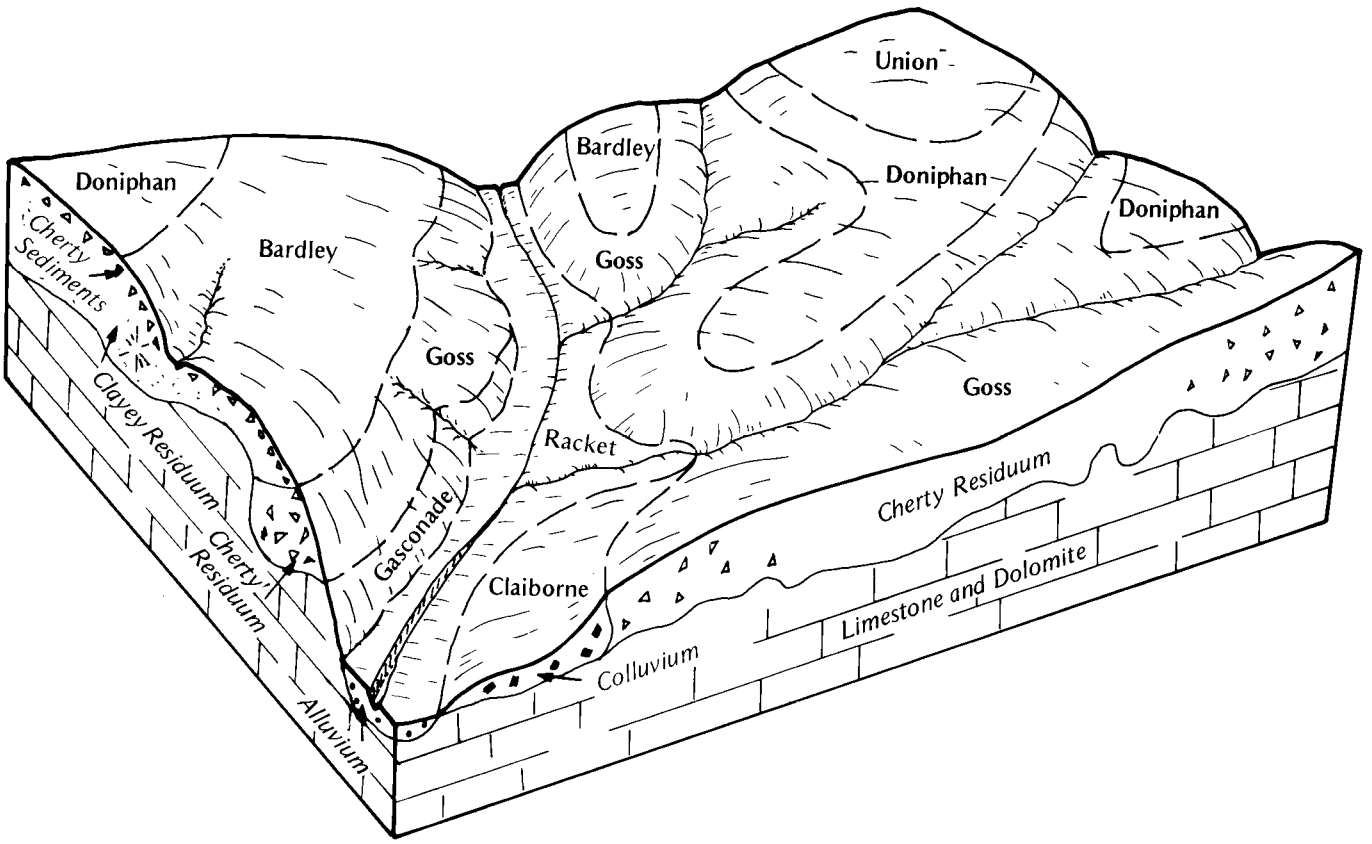

Figure 4.—Typical pattern of soils and parent material in the Goss-Bardley-Doniphan association.

the upland edge of the flood plains. Slopes range from 2 to 50 percent.

This association makes up about 36 percent of the county. It is about 35 percent Bardley soils, 16 percent Gasconade soils, 11 percent Goss soils, and 38 percent minor soils (fig. 5).

The Bardley soils are on the sides, tops, and ends of ridges. They are moderately deep, gently sloping to steep, and well drained. Typically, the surface layer is very dark grayish brown very cherty silt loam about 4 inches thick. The subsurface layer is yellowish brown very cherty silt loam about 4 inches thick. The subsoil is about 22 inches thick. The upper part is red and yellowish brown cherty silty clay loam. The lower part is red, yellowish red, and pale yellow clay and gravelly clay. Hard dolomite or limestone bedrock is at a depth of about 30 inches.

The Gasconade soils are on the sides and tops of ridges. They are shallow, gently sloping to very steep, and somewhat excessively drained. Typically, the surface layer is black flaggy silty clay loam about 8 inches thick. The subsoil is dark brown very flaggy silty clay loam about 7 inches thick. Hard limestone or dolomite bedrock is at a depth of about 15 inches.

The Goss soils are on the sides and ends of ridges. They are deep, moderately steep to very steep, and well drained. Typically, the surface layer is dark brown cherty silt loam about 5 inches thick. The subsurface layer is yellowish brown very cherty silt loam about 8 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is strong brown extremely cherty silty clay loam. The next part is red very cherty silty clay. The lower part is red very cherty clay.

The minor soils are Claiborne, Doniphan, Racket, and Union soils. The deep Claiborne soils are silty throughout and are on foot slopes and at the head of drainageways. Doniphan and Union soils are on ridgetops. The deep Doniphan soils have less chert in the subsoil than the Goss soils. Union soils have a

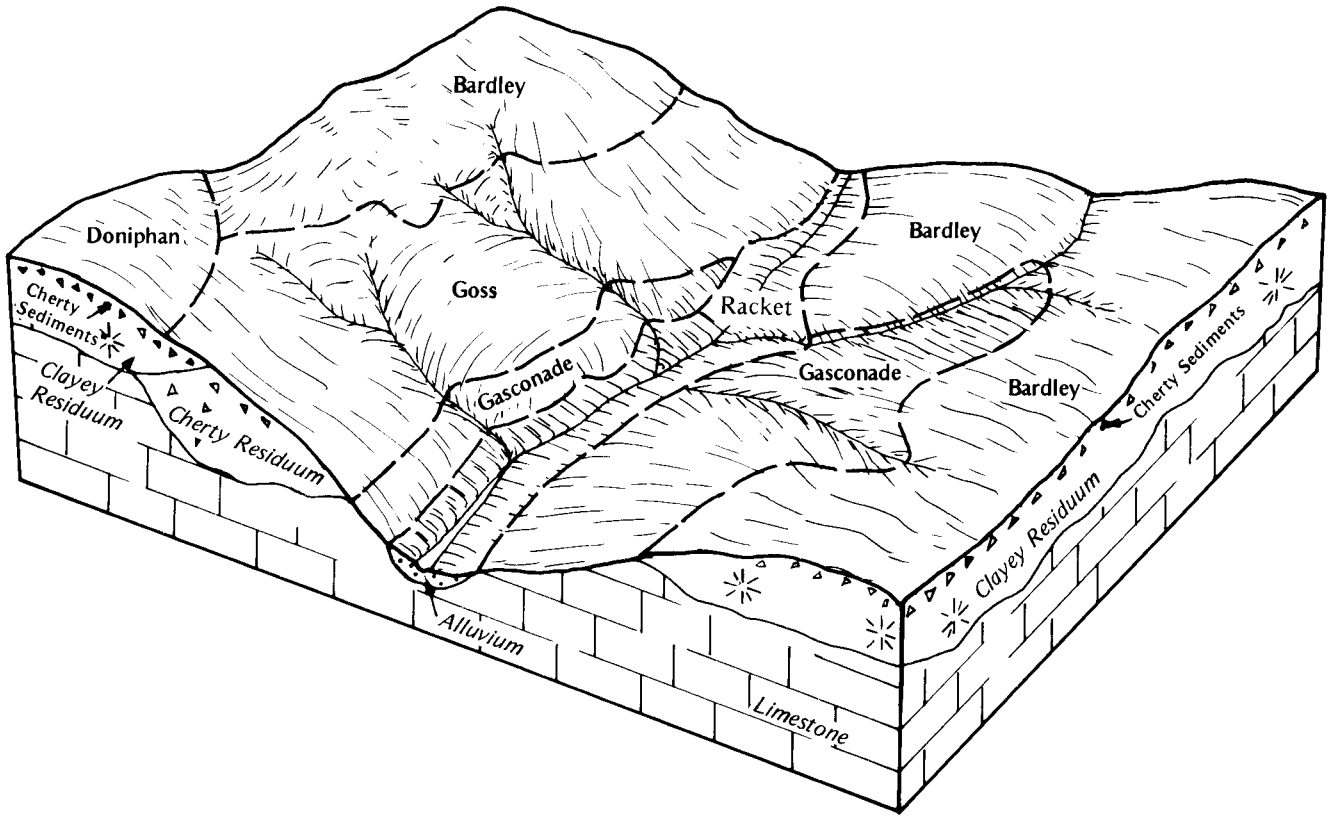

Figure 5.—Typical pattern of soils and parent material in the Bardley-Gasconade-Goss association.

fragipan. The deep, nearly level Racket soils are on flood plains.

Most areas of this association are used for second-growth timber that is harvested and sold as firewood, logs, lumber, and other wood products. Some areas are used for grasses and legumes that are fed to beef and dairy cattle.

The Bardley and Goss soils generally are suited to pasture and woodland. Trees grow fairly well on these soils. The equipment limitation, seedling mortality, and windthrow are the major management concerns in the wooded areas. Natural fertility is low in all of the major soils, and the content of organic matter is moderately low in the Goss and Bardley soils. Available water capacity is very low in the Gasconade soils. Droughtiness, the shallowness to bedrock, and the slope are the main limitations in the pastured areas.

The major soils are suitable as sites for sanitary facilities and buildings. The slope, seepage, and the depth to bedrock are moderate or severe limitations.

5. Barden-Barco-Deepwater Association

Deep and moderately deep, very gently sloping to moderately sloping, moderately well drained and well drained soils; on uplands

This association is on broad upland ridges dissected by narrow flood plains. Slopes range from 1 to 9 percent.

This association makes up about 5 percent of the county. It is about 40 percent Barden soils, 18 percent Barco and similar soils, 15 percent Deepwater soils, and 27 percent minor soils.

The Barden soils are on the broad tops of the higher ridges. They are very gently sloping and gently sloping and are moderately well drained. Typically, the surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown, mottled silty clay loam; the next part is dark grayish brown, mottled silty clay and silty clay loam; and the lower part is dark brown,

mottled silty clay loam. The substratum to a depth of 60 inches is light yellowish brown, mottled silty clay loam.

The Barco soils are on the sides and tops of ridges. They are moderately deep, gently sloping and moderately sloping, and well drained. Typically, the surface soil is very dark grayish brown loam about 13 inches thick. The subsoil is dark yellowish brown clay loam about 13 inches thick. Soft, weathered bedrock is at a depth of about 26 inches. Hard bedrock is at a depth of about 33 inches.

The Deepwater soils are on the sides and tops of ridges. They are deep, gently sloping and moderately sloping, and moderately well drained. Typically, the surface layer is very dark grayish brown silt loam about 11 inches thick. The subsoil is silty clay loam about 37 inches thick. The upper part is brown and yellowish brown and is mottled, and the lower part is mottled light brownish gray, yellowish brown, and yellowish red. The substratum to a depth of 60 inches or more is yellowish red clay loam.

The minor soils are Eldon, Hartwell, Quarles, and Verdigris soils. The deep, cherty Eldon soils are on the tops and sides of ridges. The deep, somewhat poorly drained Hartwell soils are on broad ridgetops. The deep, poorly drained Quarles soils are on low terraces. The deep, nearly level Verdigris soils are on flood plains.

About 85 percent of this association is used for grasses and legumes. About 10 percent is used for small grain or row crops, and about 5 percent is used for second-growth timber. The forage crops and most of the grain crops are fed to beef and dairy cattle. Wheat and soybeans are sold for cash. The association is well suited to grasses, legumes, and small grain. The very gently sloping and gently sloping major soils and the minor Verdigris soils on the wider flood plains are well suited to cultivated crops.

Forage and grain crops grow well on all of the major soils and on the minor Verdigris soils. Most of the soils have a high or moderate available water capacity. The main management concerns are reducing summer droughtiness and controlling erosion, especially if row crops are grown on soils that have slopes of more than 2 percent.

The major soils are suited to sanitary facilities and building site development. The main management concerns are the shrink-swell potential, restricted permeability, and wetness.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Hartwell silty clay loam, 1 to 3 percent slopes, severely eroded, is a phase of the Hartwell series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Gasconade-Rock outcrop complex, 2 to 9 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The map unit Pits and Dumps is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The descriptions, names, and delineations of soils in this survey do not fully agree with those in surveys of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas it is more feasible to combine small acreages of similar soils that respond to use and management in much the same way than it is to map these soils separately and give them different names.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

8—Pits and Dumps. This map unit consists of narrow, elongated mine pits surrounded by irregularly shaped dumps. Areas range from 5 to more than 40 acres in size. They are about 25 percent Pits and 60 percent Dumps.

Pits are open excavations from which soil material and the underlying rock have been removed. The bottom and sides consist of rock or other material that supports few or no plants. The bottom of most pits that are no longer mined is covered with water.

Dumps are strongly sloping to steep, well drained mixtures of waste rock or general refuse. They are incapable of supporting plants unless major reclamation efforts are made.

Included with the Pits and Dumps in mapping are areas of stockpiled rock or old machinery, roads, buildings, and areas of the original soil. Inclusions make up about 15 percent of the unit.

The slope, large stones, and the exposed rock restrict the suitability for land uses. This unit can support little or no vegetation. The pits typically are open at one end and do not contain enough water to be economically important. Most can be developed into a source of water for wildlife, irrigation, or livestock. If reclaimed, the smaller pits can support an adequate plant cover. As the extent and intensity of mining activities increase, the difficulty and cost of reclamation also increase.

If they are leveled and shaped before seeding, some areas are suited to grasses and legumes for pasture. An adequate plant cover helps to prevent excessive soil loss and increases the moisture supply by reducing the runoff rate. Overstocking and overgrazing reduce the extent of the protective plant cover and cause deterioration of the plant community. A planned grazing system that includes proper stocking rates and a uniform distribution of grazing help to keep the pasture in good condition.

This unit generally is unsuitable for building site development and sanitary facilities. Some areas can be used as sanitary landfills. Onsite investigation is needed to identify these areas.

No land capability classification or woodland ordination symbol is assigned.

9—Udorthents, clayey. These soils are in excavated areas from which 3 to 10 feet of soil material has been removed, mainly for use in constructing highways and levees. Areas are about 10 to more than 50 acres in size. Most are rectangular bands that parallel the highways and levees.

Typically, the surface layer is about 3 inches of yellowish brown, mottled, very firm silty clay and clay. The substratum is yellowish brown, mottled clay about 27 inches thick. Shale bedrock is at a depth of about 30 inches.

Included with these soils in mapping are small areas where bedrock is exposed and small areas of rocky or gravelly, clayey soils. Included areas make up about 5 percent of the unit.

Permeability is slow or very slow in the Udorthents. Available water capacity is low. Organic matter content is low or very low, and natural fertility is low.

Most areas have a scant to fair cover of grasses, legumes, and weeds. They are used mainly for recreational development or for grazing or are idle. In some areas the suitability for grasses and legumes and recreational development is fair or good. The suitability for trees is poor because the available water capacity is low and the clayey surface layer inhibits the emergence of seeds and the growth of seedlings.

These soils generally are unsuitable for building site development and onsite waste disposal because of a high shrink-swell potential, the restricted permeability, and the restricted depth to bedrock. Careful onsite investigation prior to construction is essential if the soils are used as building sites.

No land capability classification or woodland ordination symbol is assigned.

13B—Sampsel silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, poorly drained soil is on foot slopes. Most areas are irregular in shape and range from 5 to more than 200 acres in size.

Typically, the surface layer is very dark gray, very friable silty clay loam about 5 inches thick. The subsurface layer is very dark gray, mottled, friable silty clay loam about 5 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is very dark grayish brown, mottled, firm silty clay loam. The next part is dark grayish brown, mottled, very firm silty clay. The lower part is dark grayish brown, mottled, very firm silty clay and firm silty clay loam. In some eroded areas where small gullies have formed, the surface layer is firm silty clay loam. In places the surface layer is friable silt loam.

Included with this soil in mapping are areas of McGirk soils. These soils have a surface layer that is lighter colored than that of the Sampsel soil. They are in landscape positions similar to those of the Sampsel soil. They make up 5 to 10 percent of the unit.

Permeability is slow in the Sampsel soil. Surface runoff is medium. Available water capacity is moderate. Organic matter content also is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. A perched water table is within a depth of 1.5 feet during most winter and spring months. The shrink-swell potential is high in the subsoil.

Most areas are used for pasture or hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. The wetness caused by runoff from the higher adjacent areas is a

limitation. A system of conservation tillage that leaves a protective cover of crop residue on the surface, diversion terraces, and grassed waterways help to control erosion and reduce wetness. In a few areas where slopes are suitable, terracing and farming on the contour can help to control erosion. Returning crop residue to the soil and regularly adding other organic material improve fertility and tilth and help to prevent crusting.

This soil is moderately well suited to most of the legumes and cool-season grasses commonly grown in the county. The suitability for warm-season grasses is fair. Species that are tolerant of wetness grow best. Erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development. The high shrink-swell potential and the wetness are limitations on sites for dwellings. Properly designing the dwellings and constructing the footings and foundations with adequately reinforced concrete help to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. If the site can be leveled, sewage can be disposed of by sewage lagoons. Because of the slow permeability and the wetness, the soil is unsuitable as a site for septic tank absorption fields.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIe. No woodland ordination symbol is assigned.

13C—Sampsel silty clay loam, 5 to 9 percent slopes. This deep, moderately sloping, poorly drained soil is on foot slopes. Areas are irregular in shape and range from 5 to more than 40 acres in size.

Typically, the surface soil is very dark grayish brown and very dark gray, very friable and firm silty clay loam about 11 inches thick. The subsoil is about 29 inches thick. The upper part is very dark gray, mottled, very firm silty clay loam. The lower part is light brownish gray, mottled, very firm silty clay and silty clay loam. The substratum to a depth of 60 inches is light yellowish brown, mottled, very firm silty clay loam. In some eroded areas where small gullies have formed, the surface layer is firm silty clay.

Included with this soil in mapping are areas of Claiborne and McGirk soils. Claiborne soils are well drained and are on the upper part of the landscape. McGirk soils have a light colored surface layer. They are in landscape positions similar to those of the Sampsel soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is slow in the Sampsel soil. Surface runoff is medium. Available water capacity is moderate. Organic matter content also is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. A perched water table is within a depth of 1.5 feet during winter and spring months. The shrink-swell potential is high in the subsoil.

Most areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. The wetness caused by runoff from the higher adjacent areas is a limitation. A system of conservation tillage that leaves a protective cover of crop residue on the surface, diversion terraces, and grassed waterways help to control erosion and reduce wetness. In a few areas where slopes are suitable, terracing and farming on the contour can help to control erosion. Returning crop residue to the soil and regularly adding other organic material improve fertility and tilth and help to prevent crusting.

This soil is moderately well suited to most of the legumes and cool-season grasses commonly grown in the county. The suitability for warm-season grasses is fair. Species that are tolerant of wetness grow best. Erosion during seedbed preparation is the main problem. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development. The high shrink-swell potential and the wetness are limitations on sites for dwellings. Properly designing the dwellings and constructing the footings and foundations with adequately reinforced concrete help to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. If the site can be leveled, waste can be disposed of by sewage lagoons. Because of the slow permeability and the wetness, the soil is unsuitable as a site for septic tank absorption fields.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads

and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

15—Ashton silt loam. This deep, nearly level, well drained soil is on low stream terraces. It is occasionally flooded. Areas are irregular in shape and range from 5 to more than 40 acres in size.

Typically, the surface layer is dark brown, very friable silt loam about 10 inches thick. The subsoil is about 39 inches of dark yellowish brown, friable silt loam and silty clay loam. The substratum to a depth of 60 inches or more is mixed dark brown, dark yellowish brown, and strong brown, friable silt loam. In places the surface layer is gravelly silt loam. Some areas are frequently flooded.

Included with this soil in mapping are small areas of Claiborne, Racket, and Verdigris soils. The moderately sloping Claiborne soils are on the upper part of the landscape. Racket and Verdigris soils are adjacent to stream channels. Racket soils are darker than the Ashton soil, and Verdigris soils are moderately well drained. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Ashton soil. Surface runoff is slow. Available water capacity is high. Organic matter content is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, the occasional flooding in the spring is a hazard. Applying a system of conservation tillage that leaves crop residue on the surface and returning large amounts of crop residue to the soil improve tilth. Diversion terraces help to control runoff from the adjacent upslope soils.

This soil is well suited to most of the cool-season grasses commonly grown in the county. It is moderately well suited to most legumes and warm-season grasses. The occasional flooding is the main problem. Species that are tolerant of wetness should be selected for planting. The hazard of flooding should be considered when haying and grazing systems are designed.

A few small areas are wooded. This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil generally is unsuited to building site development and onsite waste disposal because of the occasional flooding.

The land capability classification is IIw. The woodland ordination symbol is 4A.

20B—Creldon silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on ridgetops and the upper side slopes in the uplands. Areas are irregular in shape and range from 10 to more than 150 acres in size.

Typically, the surface soil is dark brown, very friable silt loam about 14 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is yellowish brown, mottled, friable silty clay loam and mottled grayish brown, yellowish brown, and dark reddish brown, friable silty clay loam. The next part is a fragipan of pale brown, mottled, brittle very cherty silty clay loam. The lower part is strong brown and red, mottled, very firm very cherty clay. In some small areas the surface layer is dark grayish brown.

Included with this soil in mapping are small areas of a poorly drained soil. This included soil has less chert in the subsoil than the Creldon soil and is grayer throughout. It is in saddles and near the head of drainageways. Also included are some areas of the chert-free Barden soils and the well drained, cherty Eldon soils. Barden soils are in the less sloping areas where the ridgetops are broader. Eldon soils are lower on the side slopes than the Creldon soil. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderately slow above the fragipan in the Creldon soil, very slow in the fragipan, and moderately rapid below the fragipan. Surface runoff is medium. Available water capacity is moderate. Organic matter content also is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. The rooting depth is restricted by the compact fragipan. A perched high water table is at a depth of 1.5 to 3.0 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, small grain, and grain sorghum. If the soil is used for cultivated crops, erosion is a hazard. The droughtiness caused by the restricted rooting depth is a limitation. Applying a system of conservation tillage that leaves a protective amount of crop residue on the surface and

farming on the contour help to control erosion, maintain the organic matter content, improve fertility and tilth, and increase the rate of water infiltration. Terraces and waterways help to control erosion unless cuts are deep enough to expose the fragipan.

This soil is well suited to most warm-season grasses and some legumes and is moderately well suited to most cool-season grasses and legumes. The rooting depth is only moderate, and droughtiness is a problem during much of the year. Erosion during seedbed preparation is a major concern. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development. The high shrink-swell potential and the wetness are limitations on sites for dwellings without basements. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. Seepage and wetness are limitations on sites for sewage lagoons. Sealing the bottoms and berms of the lagoons with slowly permeable material helps to prevent seepage and the contamination of ground water. Constructing the bottom of the lagoon above the fragipan also helps to prevent seepage. Because of the very slow permeability and the wetness, the soil generally is unsuitable as a site for septic tank absorption fields.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIe. No woodland ordination symbol is assigned.

20C—Creldon silt loam, 5 to 9 percent slopes. This deep, moderately sloping, moderately well drained soil is on side slopes and at the head of drainageways in the uplands. Areas are irregular in shape and range from 10 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 12 inches thick. The subsurface layer is dark brown, very friable silt loam about 7 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark brown, friable and firm silty clay loam. The next part is a fragipan of yellowish red and pale brown, mottled, firm and brittle silty clay loam and very cherty silty clay loam. The lower part is dark red, mottled, very firm cherty clay. In some areas the surface layer is dark grayish brown.

Included with this soil in mapping are small areas of a poorly drained soil. This included soil has less chert than the Creldon soil and is grayer throughout. It is at the head of drainageways. Also included are small areas of the well drained, cherty Eldon soils and the poorly drained, chert-free McGirk soils. Eldon soils are in landscape positions similar to those of the Creldon soil or are on the lower slopes. McGirk soils are on concave side slopes. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately slow above the fragipan in the Creldon soil, very slow in the fragipan, and moderately rapid below the fragipan. Surface runoff is medium. Available water capacity is moderate. Organic matter content also is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. The rooting depth is restricted by the compact fragipan. A perched water table is at a depth of 1.5 to 3.0 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, sorghum, and small grain. If the soil is used for cultivated crops, erosion is a hazard. The droughtiness caused by the restricted rooting depth is a limitation. Applying a system of conservation tillage, such as no-tillage, that leaves a protective amount of crop residue on the surface and in places farming on the contour help to control erosion, maintain the organic matter content, improve fertility and tilth, and increase the rate of water infiltration. Terraces and grassed waterways help to control erosion unless cuts are deep enough to expose the fragipan.

This soil is well suited to most warm-season grasses and some legumes and is moderately well suited to most cool-season grasses and legumes. The rooting depth is only moderate, and droughtiness is a problem much of the year. Erosion during seedbed preparation is a major management concern. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suited to building site development. Wetness is a limitation on sites for dwellings with basements. The high shrink-swell potential and the

wetness are limitations on sites for dwellings without basements. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. Wetness, seepage, and slope are limitations on sites for sewage lagoons. Leveling the site and excavating below the fragipan and sealing the bottoms and berms of the lagoons help to prevent the contamination of ground water. Because of the very slow permeability and the wetness, the soil is unsuitable as a site for septic tank absorption fields.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

23F—Goss cherty silt loam, 14 to 45 percent slopes. This deep, moderately steep to very steep, well drained soil is on dissected side slopes in the uplands. Areas range from 5 to more than 300 acres in size.

Typically, the surface layer is dark brown, very friable cherty silt loam about 5 inches thick. The subsurface layer is yellowish brown, very friable very cherty silt loam about 8 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is strong brown, friable extremely cherty silty clay loam. The next part is red, firm very cherty silty clay. The lower part is red, very firm very cherty clay. In some areas the subsoil has less clay.

Included with this soil in mapping are small areas that are stony and areas where the depth to bedrock is only 40 to 60 inches. Also included are areas of Bardley, Claiborne, Doniphan, and Eldon soils and the shallow Gasconade and Knobby soils. Bardley, Claiborne, and Doniphan soils are less cherty than the Goss soil, and Eldon soils are darker. Bardley, Gasconade, and Knobby soils are in landscape positions similar to those of the Goss soil. Claiborne soils are on foot slopes, and Doniphan and Eldon soils are on the less sloping parts of the landscape. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Goss soil. Surface runoff is rapid. Available water capacity is low. Organic matter content is moderately low, and natural fertility is low. The shrink-swell potential is moderate.

Most areas are used for pasture or timber. Because of the slope, this soil generally is unsuitable as hayland. It is suited to crownvetch, lespedeza, and tall fescue and all the warm-season grasses commonly grown in the county. Droughtiness, erosion, and chert fragments in the surface layer are the main problems. Tillage should be avoided.

A large acreage supports native hardwoods. This soil is suited to trees. The equipment limitation and seedling mortality are management concerns. Planting container-grown nursery stock increases the seedling survival rate. In many places seedlings cannot be planted by machine because of the slope and the chert in the surface layer. Logging roads and skid trails should be built on the contour.

This soil generally is unsuitable for onsite waste disposal and building site development because of the slope.

The land capability classification is VIIe. The woodland ordination symbol is 3R.

30—Verdigris silt loam. This deep, nearly level, moderately well drained soil is on flood plains adjacent to stream channels. It is occasionally flooded. Areas are long and irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is dark brown, very friable silt loam about 10 inches thick. The subsurface layer is very dark grayish brown, very friable silt loam about 17 inches thick. Next is a transitional layer of dark brown, friable silt loam about 17 inches thick. The substratum to a depth of 60 inches or more is brown, mottled, friable silt loam. In some areas the substratum has less chert, and some areas are frequently flooded.

Included with this soil in mapping are some areas of the poorly drained Moniteau and Quarles soils and small areas of the well drained Racket soils. Moniteau soils are lighter colored than the Verdigris soil and have more clay in the subsoil. They are on low terraces near the uplands. Quarles soils also are on low terraces near the uplands. They are grayer than the Verdigris soil and have more clay in the subsoil. Racket soils are in positions on the landscape similar to those of the Verdigris soil or are in the lower positions. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Verdigris soil. Surface runoff is slow. Available water capacity is high. Natural fertility also is high, and organic matter content

is moderate. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for pasture. This soil is well suited to corn, grain sorghum, and small grain. If the soil is used for cultivated crops, the hazard of flooding affects the timeliness of planting and harvesting. Winter cover crops and crop residue management help to maintain tilth and increase the rate of water infiltration.

This soil is well suited to most of the cool-season grasses commonly grown in the county and is moderately well suited to most legumes and warm-season grasses. The occasional flooding is the main problem. Varieties that can withstand short periods of flooding should be selected for planting. The flooding should be considered when a grazing and haying system is designed.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings grow well if competing vegetation is controlled or removed, either by mechanical or chemical means. No other hazards or limitations affect planting or harvesting.

Because of the flooding, this soil generally is unsuitable for building site development and onsite waste disposal. It is a good source of topsoil and cover material for sanitary landfills. It tends to slough and compress when used as material for dikes and levees.

The land capability classification is IIw. The woodland ordination symbol is 4A.

32—Racket silt loam. This deep, well drained soil is on flood plains adjacent to stream channels. It is occasionally flooded for brief periods. Areas are long and irregular in shape and range from 5 to more than 80 acres in size.

Typically, the surface layer is about 7 inches of very dark grayish brown, very friable silt loam. The subsurface layer is about 35 inches thick. It is very dark grayish brown and very friable. The upper part is silt loam, and the lower part is loam. The substratum to a depth of 60 inches or more is dark yellowish brown, very friable, stratified gravelly loamy sand and extremely gravelly sand. Some areas are frequently flooded.

Included with this soil in mapping are areas of the moderately well drained Verdigris soils. These soils are in landscape positions similar to those of the Racket soil. They make up about 10 to 15 percent of the unit.

Permeability is moderate in the Racket soil. Surface runoff is slow. Available water capacity is moderate. Natural fertility is medium, and the organic matter content is moderate. A seasonal high water table is at a depth of 4 to 6 feet during most winter and spring months. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are used for pasture and hay. Some areas are used for cultivated crops. This soil is well suited to most of the legumes and cool-season grasses commonly grown in the county and is moderately well suited to most warm-season grasses. The occasional flooding is the main problem. Species that can withstand the short periods of flooding grow best on this soil. The flooding should be considered when a grazing and haying system is designed. If the soil is used for cultivated crops, measures that conserve moisture and prevent the scouring caused by floodwater are needed.

This soil is suited to trees. Seedlings survive and grow well if competing plants are removed or controlled. Proper site preparation, spraying, or cutting helps to control plant competition. No other hazards or limitations affect harvesting.

This soil generally is unsuitable for building site development and onsite waste disposal because of the flooding.

The land capability classification is IIw. The woodland ordination symbol is 5A.

33—Quarles silt loam. This deep, nearly level, poorly drained soil is on low stream terraces. It is occasionally flooded. Areas are long and irregular in shape and range from 5 to more than 160 acres in size.

Typically, the surface layer is very dark grayish brown, mottled, very friable silt loam about 9 inches thick. The subsurface layer is about 9 inches of gray, mottled, very friable silt loam. The subsoil is silty clay loam about 32 inches thick. It is gray, mottled, and friable in the upper part; dark gray, mottled, and firm in the next part; and mottled and friable in the lower part. The substratum to a depth of 60 inches or more is dark brown, mottled, friable silty clay loam. Some areas are not subject to flooding.

Included with this soil in mapping are small areas of the moderately well drained Barden and Verdigris soils and the somewhat poorly drained Hartwell soils. Barden and Hartwell soils are on the upper side slopes. Verdigris soils are on narrow flood plains. Included soils make up about 5 to 15 percent of the unit.

Permeability is slow in the Quarles soil. Surface runoff also is slow. Available water capacity is high. Organic matter content is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled. Because of the slow runoff, however, tillage is delayed by wetness and by flooding in places during

most years. A perched water table is within a depth of 1.5 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops or for pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. It is best suited to grain sorghum and small grain. In most years, planting is delayed in the spring because of wetness and yields are reduced by insufficient soil moisture during summer months. Winter cover crops and crop residue management can improve fertility, minimize crusting, and increase the rate of water infiltration and the organic matter content.

This soil is suited to hay and pasture. Shallow-rooted grasses and legumes that are tolerant of wetness should be selected for planting. The wetness and the occasional flooding are the main problems. A surface drainage system is beneficial if the deeper rooted species are grown. The hazard of flooding should be considered when haying and grazing systems are designed.

This soil is suited to the trees that are tolerant of wet conditions. Seedling mortality, the windthrow hazard, the equipment limitation, and plant competition are management concerns. Plant competition can be controlled through careful and thorough site preparation, which may include spraying and cutting. Ridging the soil and then planting on the ridges can increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. The trees should be planted and harvested when the soil is firm enough to support vehicular traffic.

This soil generally is unsuitable for building site development and onsite waste disposal because of the occasional flooding.

The land capability classification is IIw. The woodland ordination symbol is 4W.

35—Aquents, nearly level. These deep, nearly level, poorly drained soils are on bottom land where soil material has been deposited along the edges and on islands of the Lake of the Ozarks. In most places the soils are frequently flooded for long periods. Also, they are frequently ponded because of the fluctuating level of the lake. Areas generally are long and narrow and range from 5 to more than 60 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The underlying layers to a depth of 60 inches or more are dark grayish brown silty clay loam; grayish brown silt loam; and grayish brown, mottled silt loam. In places a dark, clayey buried surface layer is at a depth of 20 to 40 inches.

Included with these soils in mapping are some depressional areas that are covered with shallow water during most of the year. Included areas make up about 15 percent of the unit.

Permeability is moderate in the Aquents. Surface runoff is slow. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled. Tillage is limited, however, by the flooding, the slow runoff, and a seasonal high water table within a depth of 3 feet.

Most of the acreage is idle land. Small willows or weedy plants grow on these soils. Potholes are barren when dry. Some areas are used for hay and pasture. Grasses and legumes grow well. Varieties that can withstand frequent flooding and a high water table should be selected for planting. Grazing and haying when the soils are wet cause surface compaction and deterioration of tilth. Proper stocking rates and a system of pasture rotation which includes scheduled rest periods and restricts use during wet periods keep the pasture in good condition.

These soils are suited to trees that are tolerant of wet conditions. Pin oak, green ash, boxelder, silver maple, eastern cottonwood, and pecan trees grow well. The equipment limitation and plant competition are management concerns. Equipment should be used only during dry periods.

These soils generally are unsuitable for building site development and onsite waste disposal because of the frequent flooding.

No land capability classification or woodland ordination symbol is assigned.

50B—McGirk silt loam, 2 to 5 percent slopes. This deep, gently sloping, poorly drained soil is on concave foot slopes and side slopes at the head of drainageways in the uplands. Areas are irregular in shape and range from 5 to more than 80 acres in size.

Typically, the surface layer is dark grayish brown, very friable silt loam about 7 inches thick. The subsurface layer is about 7 inches of light brownish gray, very friable silt loam. The subsoil is about 40 inches thick. It is grayish brown, friable silty clay loam in the upper part and grayish brown, mottled, firm silty clay loam and silty clay in the lower part. The substratum to a depth of 60 inches or more is gray, mottled, firm silty clay loam. In some eroded areas the surface layer is light brownish gray silt loam.

Included with this soil in mapping are areas where the content of coarse fragments is as much as 10

percent in the surface soil and subsoil. These areas are in landscape positions similar to those of the McGirk soil. Also included are areas of Ashton, Claiborne, and Sampsel soils. The well drained Ashton soils are on low terraces. The well drained Claiborne soils are on the upper foot slopes and side slopes. Sampsel soils are darker than the McGirk soil. Their landscape positions are similar to those of the McGirk soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is slow in the McGirk soil. Surface runoff is medium. Available water capacity is moderate. Organic matter content is moderately low, and natural fertility is medium. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. A perched water table is at a depth of 0.5 foot to 2.0 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for pasture or cultivated crops. This soil is not suited to deep-rooted plants. Shallow-rooted species of grasses and legumes that are tolerant of wet conditions should be selected for pasture or hay. Erosion is the main problem. All tillage should be on the contour. Proper stocking rates and a system of pasture rotation which includes scheduled rest periods help to keep the pasture in good condition.

This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard and the wetness caused by runoff from the higher adjacent soils is a limitation. A system of conservation tillage that leaves a protective cover of crop residue on the surface helps to control erosion. Returning crop residue to the soil or regularly adding other organic material improves tilth and minimizes crusting. The wetness can be controlled by diversion terraces.

A few small areas support native hardwoods. This soil is suited to trees. The windthrow hazard and the seedling mortality rate are management concerns. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. Planting container-grown nursery stock increases the seedling survival rate. The trees should be harvested during periods when the surface is firm enough to support vehicular traffic.

This soil is suitable for building site development. The high shrink-swell potential and the wetness are limitations. Properly designing dwellings and constructing the footings and foundations with adequately reinforced concrete help to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. Because of the wetness, the soil is unsuitable as a site for septic tank absorption fields. It is suitable as a site for sewage lagoons, but the slope is a moderate limitation. This limitation can be overcome by land grading.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for dwellings. Crushed rock or other suitable material helps to prevent the damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the road damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIe. The woodland ordination symbol is 3W.

51C—Claiborne silt loam, 5 to 9 percent slopes. This deep, moderately sloping, well drained soil is at the base of foot slopes adjacent to stream valleys. Areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is dark brown, very friable silt loam about 6 inches thick. The subsurface layer is about 4 inches of dark yellowish brown, very friable silt loam. The subsoil to a depth of 60 inches or more is friable silty clay loam. It is reddish brown in the upper part, yellowish red in the next part, and yellowish red and mottled in the lower part. In some eroded areas the surface layer is yellowish red silty clay loam. In some places the subsoil is cherty, and in other places it is grayer.

Included with this soil in mapping are some areas of the cherty Bardley and Goss soils. These soils are on the upper side slopes. Also included are the somewhat poorly drained McGirk and poorly drained Sampsel soils in small concave areas. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderate in the Claiborne soil. Surface runoff is medium. Available water capacity is high. Natural fertility is low, and the organic matter content is moderately low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. In areas where it contains subsoil material, the plow layer tends to crust or puddle after hard rains. The shrink-swell potential is moderate.

Most areas support grasses and legumes. This soil is suited to small grain and to grasses and legumes for hay and pasture. Timely seeding of new stands helps to ensure a good ground cover. Nurse crops of small grain provide cover for seedlings late in the fall.

If this soil is used for cultivated crops, erosion is a

hazard. Several areas are gullied. The gullying restricts cultivation. A system of conservation tillage that leaves a protective cover of crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas slopes are long enough and smooth enough for terracing and farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration.

This soil is well suited to the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect pasture or hayland. Erosion is a problem in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

A few small areas support native hardwoods. This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled or removed. Plant competition can be controlled by proper site preparation, which may include spraying or cutting. No other hazards or limitations affect planting or harvesting.

This soil is suitable for building site development. The shrink-swell potential is a limitation on sites for dwellings, and the restricted permeability is a limitation on sites for septic tank absorption fields. Constructing the foundations and footings of dwellings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Enlarging septic tank absorption fields helps to overcome the slow absorption of liquid waste. Sewage lagoons can function adequately if sites are leveled and the berms and bottoms of the lagoons are sealed with slowly permeable material, which helps to prevent seepage and the contamination of ground water.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

52B—Deepwater silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on convex ridgetops and side slopes in the uplands. Areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is about 11 inches of very dark grayish brown, very friable silt loam. The subsoil is friable silty clay loam about 37 inches thick. The upper part is brown and yellowish brown and is mottled, and the lower part is mottled light brownish gray, yellowish brown, and yellowish red. The substratum to a depth of 60 inches or more is yellowish red, mottled, friable clay loam. In some areas the surface layer is loam. In places a few sandstone rocks are on the surface.

Included with this soil in mapping are small areas of Barco and Barden soils. The well drained Barco soils are in landscape positions similar to those of the Deepwater soil. Barden soils have more clay than the Deepwater soil and are on the broader ridgetops. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Deepwater soil. Surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. A perched water table is at a depth of 3.0 to 4.5 feet during most winter and spring months. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. A system of conservation tillage that leaves a protective cover of crop residue on the surface, contour farming, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas slopes are long enough for terracing and farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth, helps to maintain the organic matter content, and increases the rate of water infiltration.

This soil is well suited to the legumes, cool-season grasses, and warm-season grasses commonly grown in the county. No serious problems affect pasture and hayland. Erosion is a problem in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development. The shrink-swell potential and the wetness are limitations on sites for dwellings with basements. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. The wetness is a limitation on sites for sewage lagoons. Sealing the bottoms and berms of the lagoons helps to prevent the contamination of ground water. Because of

the wetness, the soil generally is unsuitable as a site for septic tank absorption fields.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIe. No woodland ordination symbol is assigned.

52C—Deepwater silt loam, 5 to 9 percent slopes. This deep, moderately sloping, moderately well drained soil is on convex side slopes and ridgetops in the uplands. Areas are irregular in shape and range from 5 to more than 40 acres in size.

Typically, the surface layer is about 13 inches of very dark grayish brown, very friable silt loam. The subsoil is silty clay loam about 42 inches thick. It is dark brown and very friable in the upper part; brown, mottled, and friable in the next part; and light brownish gray, mottled, and friable in the lower part. The substratum to a depth of 60 inches or more is light yellowish brown, mottled, firm silty clay loam. In some areas the surface layer is loam. In places a few sandstone rocks are on the surface.

Included with this soil in mapping are small areas of Barco and Barden soils. The well drained Barco soils are in landscape positions similar to those of the Deepwater soil. They are moderately deep to sandstone. Barden soils are less clayey than the Deepwater soil. They are on the less sloping, upper parts of the landscape. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Deepwater soil. Surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. A perched water table is at a depth of 3.0 to 4.5 feet during most winter and spring months. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. Erosion is a severe hazard in cultivated areas. A system of conservation tillage that leaves a protective cover of crop residue on the soil, winter cover crops, and grassed waterways help to prevent excessive soil loss. In some areas slopes are long and smooth enough for terracing and farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth, helps to maintain the organic matter content, minimizes crusting, and increases the rate of water infiltration.

This soil is well suited to the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect pasture and hayland. Erosion is a problem in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development. Wetness and the shrink-swell potential are limitations on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. The wetness and the slope are limitations on sites for sewage lagoons. Sealing the bottoms of the lagoons helps to prevent the contamination of ground water. Land grading is needed. Because of the wetness, the soil generally is unsuitable as a site for septic tank absorption fields.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

53B—Mandeville silt loam, 2 to 5 percent slopes. This moderately deep, gently sloping, well drained soil is on rounded ridgetops and the upper side slopes in the uplands. Areas are round or long and narrow and range from 5 to 75 acres in size.

Typically, the surface layer is brown, very friable silt loam about 8 inches thick. The subsoil is about 24 inches thick. It is dark brown, very friable silt loam in the upper part; strong brown, firm silty clay loam in the next part; and yellowish brown, mottled, firm silty clay loam and channery silty clay loam in the lower part. Weathered shale bedrock is at a depth of about 32 inches.

Included with this soil in mapping are small areas of Bolivar, Deepwater, and Goss soils. Bolivar soils have more clay than the Mandeville soil. They are in

landscape positions similar to those of the Mandeville soil. Deepwater soils are deep and are darker than the Mandeville soil. They are on the upper parts of the landscape. The cherty Goss soils are in the steeper areas on the lower parts of the landscape. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Mandeville soil. Surface runoff is medium. Available water capacity is moderate. Organic matter content is moderately low, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. The root zone is restricted by the shale bedrock at a depth of about 32 inches.

Most areas are used for hay and pasture. This soil is well suited to most warm-season grasses and to birdsfoot trefoil and is moderately well suited to most cool-season grasses and legumes. Erosion is a major concern if the pasture is tilled before it is seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss. Insufficient soil moisture is a problem during most summer months.

This soil is suited to soybeans, sorghum, and small grain. Corn can be grown, but in most years yields are reduced because of insufficient soil moisture. Erosion is a hazard in cultivated areas. A system of conservation tillage that leaves a protective cover of crop residue on the soil, winter cover crops, and grassed waterways help to prevent excessive soil loss. If terraces are built, cuts should not be deep because of the moderate depth to shale. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth, minimizes crusting, and increases the rate of water infiltration.

Some areas support native hardwoods. This soil is suited to trees. Windthrow is a hazard. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. No other hazards or limitations affect planting or harvesting.

This soil is suited to building site development. The moderate depth to soft bedrock is a limitation on sites for dwellings with basements; however, the bedrock can be ripped and dug with some difficulty. The depth to bedrock also is a limitation on sites for septic tank absorption fields. A properly constructed mound system increases the absorption rate above the bedrock. Extra soil can be hauled in if needed. Seepage is a problem on sites for sewage lagoons. Sealing the bottoms and berms of the lagoons with slowly permeable material helps to prevent seepage. Also, the sewage can be piped to adjacent areas where the soil is better suited to onsite waste disposal.

Low strength and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by frost action.

The land capability classification is IIe. The woodland ordination symbol is 3D.

54—Moniteau silt loam. This deep, nearly level, poorly drained soil is on low stream terraces. It is subject to rare flooding. Areas are long and irregular in shape and range from 5 to more than 200 acres in size.

Typically, the surface layer is grayish brown, very friable silt loam about 8 inches thick. The subsurface layer is about 6 inches of light brownish gray, mottled, very friable silt loam. The subsoil is grayish brown, light brownish gray, and dark grayish brown, mottled, friable silty clay loam about 35 inches thick. The substratum to a depth of 60 inches or more is gray, mottled, friable silty clay loam. Some areas are occasionally flooded.

Included with this soil in mapping are small areas of Quarles, Racket, and Verdigris soils. Quarles soils are darker and more clayey than the Moniteau soil. They are near the center of the mapped areas. The well drained Racket and moderately well drained Verdigris soils are on flood plains near the stream channels. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Moniteau soil. Surface runoff is slow. Available water capacity is high. Organic matter content is moderately low, and natural fertility is low. The surface layer is very friable and can be easily tilled. Because of the slow runoff, however, tillage is delayed by wetness in some areas during most years. A perched water table is within a depth of 1 foot during most winter and spring months. The shrink-swell potential is moderate.

Most areas are used for cultivated crops or for pasture. This soil is suited to soybeans, grain sorghum, and small grain. Corn can be grown, but yields generally are reduced by wetness in the spring and by insufficient soil moisture in the summer. Applying a system of conservation tillage that leaves a protective cover of crop residue on the soil, returning crop residue to the soil, and planting winter cover crops improve fertility, minimize crusting, and increase the rate of water infiltration.

This soil is better suited to shallow-rooted forage species that are tolerant of wetness than to other forage species. It is poorly suited to hay. The wetness is the main problem. In depressional areas maintaining stands

of desirable species is difficult. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil is suited to trees. Species that are tolerant of wetness should be selected for planting. The equipment limitation, seedling mortality, and windthrow are management concerns. Ridging the soil and then planting on the ridges can increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. Trees should be planted and harvested during periods when the soil is firm enough to support vehicular traffic.

This soil generally is unsuitable for building site development and onsite waste disposal because of the flooding.

The land capability classification is IIIw. The woodland ordination symbol is 4W.

55B—Barco loam, 2 to 5 percent slopes. This moderately deep, gently sloping, well drained soil is on convex ridgetops, mounds, and the upper side slopes in the uplands. Areas are irregular in shape and range from 5 to more than 40 acres in size.

Typically, the surface soil is very dark grayish brown, very friable loam about 13 inches thick. The subsoil is about 13 inches of dark yellowish brown, friable clay loam. Soft, weathered bedrock is at a depth of about 26 inches. In some areas scattered sandstone rocks are on the surface.

Included with this soil in mapping are some areas of Barden, Creldon, Deepwater, and Eldon soils. Barden soils have more clay in the subsoil than the Barco soil. Also, they are in higher landscape positions. Creldon and Eldon soils are deep, have cherty horizons, and are in landscape positions similar to or lower than those of the Barco soil. Deepwater soils are deep and are in landscape positions similar to those of the Barco soil. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Barco soil. Surface runoff is medium. Available water capacity is low. Natural fertility is medium, and organic matter content is moderately low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. The root zone is restricted in most places by the soft sandstone bedrock at a depth of about 26 inches. The shrink-swell potential is moderate.

Most areas are used as tall fescue pasture. This soil is suited to corn, soybeans, and grain sorghum. Erosion is a hazard in cultivated areas. Yields of summer row crops are reduced by insufficient soil moisture during most years. Terraces and grassed waterways help to control erosion unless cuts are deep enough to expose bedrock. A system of conservation tillage, such as no-tillage, that leaves a protective cover of crop residue on the surface helps to control erosion, maintain the organic matter content, improve fertility and tilth, and increase the rate of water infiltration.

This soil is well suited to most warm-season grasses and to birdsfoot trefoil and is moderately suited to most cool-season grasses and legumes. The moderate rooting depth and droughtiness are limitations. Erosion is a major concern if the pasture is tilled before it is seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suitable for building site development. The shrink-swell potential is a limitation on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. The underlying sandstone strata are relatively soft and can be excavated in most places. The depth to bedrock is a limitation on sites for septic tank absorption fields. A properly constructed mound system increases the absorption rate above the bedrock. Seepage is a limitation on sites for sewage lagoons. Sealing the sides and bottoms of the lagoons with slowly permeable material helps to overcome this limitation. Also, the sewage can be piped to adjacent areas where the soil is better suited to onsite waste disposal.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIe. No woodland ordination symbol is assigned.

55C—Barco loam, 5 to 9 percent slopes. This moderately deep, moderately sloping, well drained soil is on ridgetops and side slopes and at the head of drainageways in the uplands. Areas are irregular in shape and range from 5 to more than 50 acres in size.

Typically, the surface layer is about 9 inches of dark brown, very friable loam. The subsoil is friable clay loam about 21 inches thick. The upper part is yellowish brown, and the lower part is light yellowish brown. Soft sandstone bedrock is at a depth of about 30 inches. In some areas scattered sandstone rocks are on the

surface. In other areas the soil is deep to sandstone bedrock.

Included with this soil in mapping are small areas of Barden, Creldon, Deepwater, and Eldon soils. Barden soils have more clay in the subsoil than the Barco soil. Also, they are in higher landscape positions. Creldon and Eldon soils are deep, have cherty horizons, and are on the lower parts of the landscape. Deepwater soils are deep and are in landscape positions similar to those of the Barco soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Barco soil. Surface runoff is rapid. Available water capacity is low. Natural fertility is medium, and organic matter content is moderately low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. The root zone is restricted by the soft sandstone bedrock at a depth of about 30 inches. The shrink-swell potential is moderate.

Most areas are used as tall fescue pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a severe hazard in cultivated areas. Yields of summer row crops are reduced by insufficient soil moisture during most years. Terraces and grassed waterways help to control erosion unless cuts are deep enough to expose bedrock. A system of conservation tillage, such as no-tillage, that leaves a protective cover of crop residue on the surface or regular additions of other organic matter help to control erosion, maintain the organic matter content, improve fertility and tilth, and increase the rate of water infiltration.

This soil is well suited to most warm-season grasses and to birdsfoot trefoil and is moderately suited to most cool-season grasses and legumes. The moderate rooting depth and droughtiness are limitations. Erosion is a major concern if the pasture is tilled before it is seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

This soil is suitable for building site development. The shrink-swell potential is a limitation on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. The underlying sandstone strata are relatively soft and can be excavated in most places. The depth to bedrock is a limitation on sites for septic tank absorption fields. A properly constructed mound system increases the absorption rate above the bedrock. Seepage is a limitation on sites for sewage lagoons. Sealing the sides and bottoms of the lagoons with slowly permeable material helps to overcome this limitation. Also, the sewage can be piped to adjacent areas where the soil is better suited to onsite waste disposal.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

56C—Bolivar fine sandy loam, 5 to 9 percent slopes. This moderately deep, moderately sloping, well drained soil is on convex ridgetops and uneven side slopes in the uplands. Areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is brown, very friable fine sandy loam about 8 inches thick. The subsoil is friable clay loam about 18 inches thick. It is strong brown in the upper part, strong brown and mottled in the next part, and dark yellowish brown and mottled in the lower part. Soft sandstone bedrock is at a depth of about 26 inches. In some areas, the subsoil is not so thick and the sandstone bedrock is less than 20 inches below the surface.

Included with this soil in mapping are areas of Barco and Goss soils. Barco soils have a dark surface layer and are on the upper parts of the landscape. Goss soils are cherty throughout and are in the steeper areas. Included soils make up about 5 to 15 percent of the unit.

Permeability is moderate in the Bolivar soil. Surface runoff is rapid. Available water capacity is low. Natural fertility and organic matter content also are low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. The root zone is restricted by the soft sandstone bedrock at a depth of about 26 inches. The shrink-swell potential is moderate.

Most areas are used for pasture or timber, and a small acreage is used for hay. This soil is better suited to small grain than to corn, soybeans, and grain sorghum; however, these crops can be grown on a limited basis. Erosion is a severe hazard in cultivated areas. Yields of summer row crops are reduced by insufficient soil moisture during most years. Terraces and grassed waterways help to control erosion unless cuts are deep enough to expose bedrock. A system of conservation tillage, such as no-tillage, that leaves a protective amount of crop residue on the surface helps

to control erosion, maintain the organic matter content, improve fertility and tilth, and increase the rate of water infiltration.

This soil is well suited to most warm-season grasses and to birdsfoot trefoil and is moderately suited to most cool-season grasses and legumes. The moderate rooting depth and droughtiness are limitations. Erosion is a major concern if the pasture is tilled before it is seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few areas support native hardwoods. This soil is suited to trees. Windthrow is a hazard. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. No other hazards or limitations affect planting or harvesting.

This soil is suitable for building site development. The shrink-swell potential is a limitation on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. The underlying sandstone bedrock is relatively soft and can be excavated in most places. The moderate depth to bedrock is a limitation on sites for septic tank absorption fields. A properly constructed mound system increases the absorption rate above the bedrock. Seepage is a limitation on sites for sewage lagoons. Sealing the sides and bottoms of the lagoons with slowly permeable material helps to overcome this limitation. Also, the sewage can be piped to adjacent areas where the soil is better suited to onsite waste disposal.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIe. The woodland ordination symbol is 3D.

56D—Bolivar fine sandy loam, 9 to 14 percent slopes. This moderately deep, strongly sloping, well drained soil is on convex, short, uneven side slopes in the uplands. Areas are irregular in shape and range from 5 to more than 40 acres in size.

Typically, the surface soil is dark grayish brown and brown, very friable fine sandy loam about 11 inches thick. The subsoil is friable clay loam about 15 inches thick. It is brown in the upper part and yellowish brown and mottled in the lower part. Soft sandstone bedrock is at a depth of about 26 inches. Hard sandstone bedrock is at a depth of about 40 inches. In some areas, the subsoil is not so thick and the sandstone bedrock is less than 20 inches below the surface.

Included with this soil in mapping are areas that have a slope of more than 14 percent and breaks that have rock outcrops and stones and boulders on the surface. Also included are small areas of Bardley and Goss soils. Bardley soils have a cherty surface layer and have more clay in the subsoil than the Bolivar soil. They are on the lower parts of the side slopes. Goss soils are deep and are cherty throughout. They are on the lower, steeper parts of the landscape. Included areas make up about 5 to 15 percent of the unit.

Permeability is moderate in the Bolivar soil. Surface runoff is rapid. Available water capacity is low. Natural fertility and organic matter content also are low. In most places the root zone is restricted by the soft sandstone bedrock at a depth of about 26 inches. The shrink-swell potential is moderate.

Most areas are forested. This soil is suited to corn, soybeans, grain sorghum, and small grain only if these crops are grown on a very limited basis. Erosion is a severe hazard in cultivated areas. Yields of summer row crops are reduced by insufficient soil moisture during most years.

This soil is well suited to birdsfoot trefoil, lespedeza, red fescue, big and little bluestem, and indiangrass. It is moderately well suited to most legumes and cool-season grasses. Shallow-rooted species that are tolerant of droughtiness should be selected for planting. Erosion is a serious hazard if the pasture is tilled before it is seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

Most areas support native hardwoods. This soil is suited to trees. Windthrow is a hazard. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. The only other limitations that affect planting or harvesting are the stones and boulders on the surface in some included areas.

This soil is suitable for building site development. The shrink-swell potential, the slope, and the depth to bedrock are limitations. Constructing the foundations and footings of dwellings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Land shaping or designing the buildings so that they conform to the natural slope of the land helps to overcome the slope. The underlying sandstone bedrock is relatively soft and can be

excavated in most places. The depth to bedrock is a limitation on sites for dwellings with basements. The hard rock can be excavated by blasting. Otherwise, the dwellings should be built in areas where the soil is better suited to such construction. The soil generally is unsuitable for onsite waste disposal because of the slope and the moderate depth to sandstone bedrock. The sewage generally can be piped to adjacent areas where the soil is better suited to onsite waste disposal.

Low strength, the shrink-swell potential, frost action, and the slope are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus help to minimize the damage caused by shrinking and swelling and by frost action. The roads should be designed so that they conform to the topography. Some cutting and filling generally is necessary.

The land capability classification is IVe. The woodland ordination symbol is 3D.

58—Hartwell silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad ridgetops in the uplands. Areas generally are long and broad and range from 10 to more than 800 acres in size.

Typically, the surface soil is very dark grayish brown and dark grayish brown, very friable silt loam about 13 inches thick. The subsoil is about 21 inches thick. It is very dark grayish brown, mottled, very firm clay in the upper part; grayish brown, mottled, very firm silty clay in the next part; and grayish brown, mottled, firm silty clay loam in the lower part. The substratum to a depth of 60 inches or more is olive gray and gray, mottled, friable silty clay loam. In some eroded areas the surface layer is less than 8 inches of silt loam or is silty clay loam or silty clay.

Included with this soil in mapping are areas of the moderately well drained Barden and Deepwater soils. Barden soils are on the higher mounds and in the steeper downslope areas. Deepwater soils are on ridgetops and the lower parts of side slopes. Included soils make up about 5 to 10 percent of the unit.

Permeability is slow in the Hartwell soil. Surface runoff also is slow. Available water capacity is high. Organic matter content is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. A perched water table is at a depth of about 0.5 foot to 1.5 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard in cultivated areas. Wetness is a limitation in most spring and fall months. It often delays planting and harvesting. During the midsummer dry period, insufficient soil moisture is a limitation affecting row crops. A system of conservation tillage, such as no-tillage, that leaves large amounts of crop residue on the surface conserves soil moisture and helps to prevent excessive soil loss. Using crop rotations, returning crop residue to the soil, and regularly adding other organic material improve fertility, minimize crusting, and increase the rate of water infiltration.

This soil is suited to grasses and legumes. A system of conservation tillage that leaves a protective cover on the surface helps to prevent excessive soil loss in newly seeded areas. The seasonal wetness and the midsummer droughtiness are limitations. Seeding the more shallow rooted species of grasses and clovers that can withstand the wetness helps to keep forage production at an acceptable level. Overgrazing or grazing when the soil is wet results in surface compaction, excessive runoff, and poor tilth.

This soil is suited to building site development. The wetness and the high shrink-swell potential are limitations on sites for dwellings. Installing tile drains around the footings helps to prevent the structural damage caused by excessive wetness. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the damage caused by shrinking and swelling. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIe. No woodland ordination symbol is assigned.

58B2—Hartwell silt loam, 1 to 3 percent slopes, eroded. This very gently sloping, somewhat poorly drained soil is on broad ridges in the uplands. Typically,

erosion has removed about 5 inches of the original surface layer. Areas are irregular in shape and range from 100 to more than 160 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 8 inches thick. The subsoil is about 39 inches thick. It is mixed very dark grayish brown and dark grayish brown, very firm silty clay in the upper part; mottled dark grayish brown, light gray, and yellowish brown, very firm silty clay loam in the next part; and mottled yellowish brown and light gray, firm silty clay loam in the lower part. The substratum to a depth of 60 inches or more is mottled yellowish brown and light gray, firm silty clay loam. In some small areas, the soil is severely eroded and the surface layer is silty clay loam or silty clay. In places the dark surface layer is more than 10 inches thick.

Included with this soil in mapping are some areas of poorly drained soils that have a grayish brown surface soil 26 to 30 inches thick. These soils are on the lower side slopes near drainageways. They make up 5 to 10 percent of the unit.

Permeability is slow in the Hartwell soil. Surface runoff also is slow. Available water capacity is high. Organic matter content is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. A perched water table is at a depth of 0.5 foot to 1.5 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard in cultivated areas. Wetness is a limitation in most spring and fall months. It often delays planting and harvesting. During the midsummer dry period, insufficient soil moisture is a limitation affecting row crops. As a result, the plant population of corn should be limited. A system of conservation tillage, such as no-tillage, that leaves a protective cover of crop residue on the surface conserves soil moisture during the summer growing period and helps to prevent excessive soil loss. Tilth, fertility, and the available water capacity are adversely affected if terracing exposes the clayey subsoil. This problem can be avoided by stockpiling the topsoil from the area where the terrace will be constructed and redistributing it over the channel area after construction. Using crop rotations, returning crop residue to the soil, or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to grasses and legumes for pasture and hay. A system of conservation tillage that leaves a protective cover on the surface helps to prevent excessive soil loss in newly seeded areas. The seasonal wetness and midsummer droughtiness are limitations. Seeding the more shallow rooted species of grasses and clover that can withstand the wetness helps to keep forage production at an acceptable level. Overgrazing or grazing when the soil is wet results in surface compaction, excessive runoff, and poor tilth.

This soil is suited to building site development. The wetness and the high shrink-swell potential are limitations on sites for dwellings. Installing tile drains around the footings helps to prevent the structural damage caused by excessive wetness. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the damage caused by shrinking and swelling. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIe. No woodland ordination symbol is assigned.

58B3—Hartwell silty clay loam, 1 to 3 percent slopes, severely eroded. This deep, very gently sloping, somewhat poorly drained soil is on broad ridgetops and the upper side slopes in the uplands. The original dark surface layer of silt loam has eroded away, and the present surface layer is mostly subsoil material. Areas generally are rectangular and range from 5 to more than 30 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay loam about 5 inches thick. The subsoil is about 40 inches thick. It is very dark grayish brown, very firm silty clay in the upper part; grayish brown, mottled silty clay loam in the next part; and light gray, mottled, firm silty clay loam in the lower part. The substratum to a depth of 60 inches or more is mottled light gray and yellowish brown, firm silty clay loam.

Included with this soil in mapping are small areas of eroded and uneroded Hartwell soils. These soils are

throughout the unit but generally are around the edges of the mapped areas. They make up about 5 percent of the unit.

Permeability is slow in the Hartwell soil. Surface runoff also is slow. Available water capacity is high. Organic matter content and natural fertility are low. The surface layer is firm and plastic during wet periods. It tends to crust or puddle after hard rains and to form large clods if tilled when wet. A perched water table is at a depth of 0.5 foot to 1.5 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops. In most places this soil is farmed along with the eroded and uneroded Hartwell soils. It is suited to soybeans, grain sorghum, and small grain. Erosion is a hazard in cultivated areas. Wetness is a limitation in most spring and fall months. It often delays planting and harvesting. During the midsummer dry period, insufficient soil moisture generally is a limitation affecting row crops. A system of conservation tillage, such as no-tillage, that leaves a protective cover of crop residue on the surface conserves soil moisture and helps to prevent excessive soil loss. Tilth, fertility, and the available water capacity are adversely affected if terracing exposes the clayey subsoil. This problem can be avoided by stockpiling the topsoil from the area where the terrace is to be constructed and redistributing it over the channel area after construction. Using crop rotations, returning crop residue to the soil, or regularly adding other organic material improves fertility and tilth, minimizes crusting, and increases the rate of water infiltration.

A few areas support grasses and legumes for pasture and hay. A system of conservation tillage that leaves a protective cover on the surface helps to prevent excessive soil loss in newly seeded areas. The seasonal wetness and insufficient soil moisture during summer months are limitations. Seeding the more shallow rooted species of grasses and clover that can withstand the wetness helps to keep forage production at an acceptable level. Overgrazing or grazing when the soil is wet results in surface compaction, excessive runoff, and poor tilth.

This soil is suited to building site development. The wetness and the high shrink-swell potential are limitations on sites for dwellings. Installing tile drains around the footings helps to prevent the structural damage caused by excessive wetness. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the damage caused by shrinking and swelling. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

60B—Barden silt loam, 1 to 5 percent slopes. This deep, very gently sloping and gently sloping, moderately well drained soil is on convex ridgetops and side slopes in the uplands. Areas generally are irregular in shape and range from 10 to more than 300 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 11 inches thick. The subsoil is about 23 inches thick. It is dark brown, mottled, friable silty clay loam in the upper part; dark grayish brown, mottled, very firm silty clay and silty clay loam in the next part; and dark brown, mottled, friable silty clay loam in the lower part. The substratum to a depth of 60 inches or more is light yellowish brown, mottled, friable silty clay loam.

Included with this soil in mapping are small areas of Barco, Creldon, Deepwater, and Hartwell soils. Barco soils are moderately deep and are on mounds and the lower side slopes. Creldon soils have a fragipan. They are on the lower parts of the landscape. Deepwater soils have less clay in the subsoil than the Barden soil. They are in landscape positions similar to those of the Barden soil. Hartwell soils have more clay than the Barden soil. They are nearly level and are on the broader ridgetops. Included soils make up about 5 to 15 percent of the unit.

Permeability is slow in the Barden soil. Surface runoff is medium. Available water capacity is moderate or high. Organic matter content is moderate, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. A perched water table is at a depth of 2 to 3 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Water erosion is a hazard in cultivated areas. The soil tends to remain wet during the spring and fall. The wetness often delays planting and harvesting. A

system of conservation tillage, such as no-tillage, that leaves a protective cover of crop residue on the surface, winter cover crops, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Using crop rotations, returning crop residue to the soil, or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is moderately well suited to most of the cool-season grasses and legumes commonly grown in the county. The suitability of the soil for warm-season grasses is fair. Species that are tolerant of wetness should be selected for planting. Erosion is the main problem during seedbed preparation. Timely tillage and a quickly established ground cover help to prevent excessive soil loss. Overgrazing or grazing when the soil is wet results in surface compaction, excessive runoff, and poor tilth.

This soil is suited to building site development. The shrink-swell potential and the wetness are limitations on sites for dwellings. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by wetness. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIe. No woodland ordination symbol is assigned.

60B2—Barden silt loam, 1 to 5 percent slopes, eroded. This deep, very gently sloping and gently sloping, moderately well drained soil is on convex ridgetops and side slopes in the uplands. Typically, erosion has removed 4 to 6 inches of the original dark surface layer. Areas generally are irregular in shape and range from 5 to more than 60 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 7 inches thick. The subsoil is about 35 inches thick. It is very dark brown, friable silty clay loam in the upper part; grayish brown, mottled, very firm silty clay and silty clay loam in the next part; and grayish brown, mottled, firm silty clay loam in the lower part. The substratum to a depth of 60 inches or more is brown and grayish brown, mottled, friable silty clay loam and clay loam. The surface layer is dark brown, friable silty clay loam in areas where it has been mixed with the subsoil by plowing.

Included with this soil in mapping are small areas of Barco, Creldon, Deepwater, and Hartwell soils. Barco soils are moderately deep and are on mounds and the lower side slopes. Creldon soils have a fragipan and are on the lower side slopes. Deepwater soils have less clay than the Barden soil. They are in landscape positions similar to those of the Barden soil. Hartwell soils have more clay than the Barden soil and are on the broader ridgetops. Included soils make up about 5 to 15 percent of the unit.

Permeability is slow in the Barden soil. Surface runoff is medium. Available water capacity is moderate or high. Organic matter content is moderately low, and natural fertility is medium. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. A perched water table is at a depth of 2 to 3 feet during most winter and spring months. The shrink-swell potential is high.

Most areas are used for cultivated crops. Many areas are used for pasture and hay. This soil is suited to corn, soybeans, grain sorghum, and small grain. It tends to remain wet in spring and fall. The wetness often delays planting and harvesting. Erosion is a severe hazard in cultivated areas. A system of conservation tillage, such as no-tillage, that leaves a protective cover of crop residue on the surface, winter cover crops, grassed waterways, terraces, and contour farming help to prevent further soil loss. Tilth, fertility, and the available water capacity are adversely affected if terracing exposes the clayey subsoil. This problem can be avoided by stockpiling the topsoil from the area where the terrace will be constructed and redistributing it over the channel area after construction. Using crop rotations, returning crop residue to the soil, or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is moderately well suited to most of the cool-season grasses and legumes commonly grown in the county. The suitability for warm-season grasses is fair. A system of conservation tillage that leaves a protective cover on the surface helps to prevent excessive soil loss in newly seeded areas. Species that are tolerant of wetness should be selected for planting. Overgrazing or grazing when the soil is wet results in

surface compaction, excessive runoff, and poor tilth.

This soil is suited to building site development. The shrink-swell potential and the wetness are limitations on sites for dwellings. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by wetness. The soil generally is unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability. Properly designed sewage lagoons can function adequately.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

63B—Union silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on broad ridgetops and the upper side slopes in the uplands. Areas are irregular in shape and range from 10 to more than 200 acres in size.

Typically, the surface layer is dark brown, very friable silt loam about 4 inches thick. The subsurface layer is yellowish brown, very friable silt loam about 3 inches thick. The subsoil extends to a depth of 60 inches or more. In sequence downward, it is dark yellowish brown, friable and firm silty clay loam; dark yellowish brown and grayish brown, mottled, firm silty clay loam; a fragipan of grayish brown and pale brown, mottled, brittle very cherty silty clay loam; and red and strong brown, mottled, very firm very cherty and cherty clay. In some areas the surface layer and subsurface layer are yellowish brown.

Included with this soil in mapping are some areas of a deep, somewhat poorly drained soil that does not have a fragipan or has a weakly expressed fragipan. This included soil is in landscape positions similar to those of the Union soil. Also included are small areas of Bardley and Doniphan soils. Bardley soils are moderately deep to limestone and are lower on the landscape than the Union soil. Doniphan soils have more clay than the Union soil and have a cherty surface layer. They are on narrow ridgetops and on mounds. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate above the fragipan in the Union soil and slow in the fragipan. Surface runoff is medium. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderately low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. The rooting depth is restricted by the compact fragipan at a depth of about 29 inches. A perched water table is at a depth of 1.5 to 3.0 feet during most winter and spring months. The shrink-swell potential is moderate.

Most areas are used for pasture or timber. This soil is suited to corn, soybeans, and small grain. Erosion is a hazard if cultivated crops are grown. A system of conservation tillage that leaves a protective cover of crop residue on the surface and winter cover crops help to prevent excessive soil loss. In a few areas slopes are long enough and smooth enough to be farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is suited to most warm-season grasses and to birdsfoot trefoil and is moderately suited to most cool-season grasses and legumes. The rooting depth is only moderate, and droughtiness is a problem during much of the year. Erosion is a major concern if the pasture is tilled before it is seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few small areas support native hardwoods. This soil is suited to trees. Windthrow is a hazard. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. No hazards or limitations affect harvesting.

This soil is suited to building site development. The wetness and the shrink-swell potential are limitations on sites for dwellings. Constructing the footings and foundations with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. The wetness is a limitation on sites for sewage lagoons. Sealing the sides and bottoms of the lagoons helps to prevent the contamination of ground water. The soil is generally unsuitable as a site for septic tank absorption fields because of the wetness and the slow permeability.

Low strength, the shrink-swell potential, frost action,

and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIe. The woodland ordination symbol is 3D.

63C—Union silt loam, 5 to 9 percent slopes. This deep, moderately sloping, moderately well drained soil is on broad ridgetops and the upper side slopes in the uplands. Areas are irregular in shape and range from 5 to more than 50 acres in size.

Typically, the surface layer is brown, very friable silt loam about 7 inches thick. The subsoil extends to a depth of 60 inches or more. In sequence downward, it is dark brown, firm silty clay loam; dark yellowish brown, very firm silty clay; a fragipan of dark yellowish brown, dark grayish brown, and brown, mottled, very firm and brittle silty clay loam and cherty silty clay loam; and red, firm very cherty silty clay loam. In some areas the surface layer is yellowish brown.

Included with this soil in mapping are some areas of Bardley, Doniphan, and Goss soils, which do not have a fragipan. Bardley soils are on the lower side slopes. Doniphan soils are in landscape positions similar to those of the Union soil. Goss soils are in the steeper areas. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate above the fragipan in the Union soil and slow in the fragipan. Surface runoff is medium. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderately low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains. The rooting depth is restricted by the compact fragipan at a depth of about 26 inches. A perched water table is at a depth of 1.5 to 3.0 feet during most winter and spring months. The shrink-swell potential is moderate.

Most areas are used for pasture or timber. This soil is suited to corn, soybeans, and small grain. Erosion is a severe hazard if cultivated crops are grown. A system of conservation tillage, such as no-tillage, that leaves a protective cover of residue on the surface helps to control erosion, maintain the organic matter content, improve tilth and fertility, and increase the rate of water infiltration.

This soil is well suited to most warm-season grasses and to birdsfoot trefoil and is moderately well suited to most cool-season grasses and legumes. The rooting depth is only moderate, and droughtiness is a problem during much of the year. Erosion is a major concern if the pasture is tilled before it is seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

A few areas support native hardwoods. This soil is suited to trees. Windthrow is a hazard. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. No hazards or limitations affect harvesting.

This soil is suitable for building site development. The wetness and the shrink-swell potential are limitations on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. The slope and the wetness are limitations on sites for sewage lagoons. Sealing the sides and bottoms of the lagoons helps to prevent the contamination of ground water. Grading and leveling help to overcome the slope. The soil is generally unsuitable as a site for septic tank absorption fields because of the slow permeability and the wetness.

Low strength, the shrink-swell potential, frost action, and the wetness are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. The woodland ordination symbol is 3D.

66C—Doniphan cherty silt loam, 3 to 9 percent slopes. This deep, gently sloping and moderately sloping, well drained soil is on narrow, convex ridgetops and short, uneven side slopes in the uplands. Areas are irregular in shape and range from 10 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, very friable cherty silt loam about 3 inches thick. The subsurface layer is brown, very friable cherty silt loam about 5 inches thick. The subsoil extends to a depth of 60 inches or more. It is yellowish red, mottled, firm cherty clay in the upper part and red and dark red, mottled, very firm clay in the lower part. In some areas the surface layer has less chert.

Included with this soil in mapping are small areas of Bardley, Goss, and Union soils. Bardley soils are moderately deep to limestone or dolomite and are in landscape positions similar to those of the Doniphan soil. Goss soils are cherty throughout and are on the steeper side slopes. Union soils have a fragipan and have less clay than the Doniphan soil. They are on the broader ridgetops. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Doniphan soil. Surface runoff is medium. Available water capacity is low. Natural fertility and organic matter content also are low. The rooting depth for some plants is restricted because reaction is very strongly acid. The shrink-swell potential is moderate.

Most areas are used for pasture or timber. This soil is moderately suited to crownvetch, lespedeza, tall fescue, and all of the warm-season grasses commonly grown in the county. It generally is unsuited to hay because of the chert fragments on the surface. Droughtiness, the erosion hazard, and the chert fragments in the surface layer are the main management concerns. Tillage should be avoided.

A few areas support native hardwoods. This soil is suited to trees. The use of planting equipment is restricted because of the chert in the surface layer. Hand planting may be necessary. No other hazards or limitations affect planting or harvesting.

This soil is suitable for building site development. The shrink-swell potential is a limitation on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. The moderate permeability is a limitation on sites for septic tank absorption fields. Enlarging the absorption field helps to overcome this limitation. The soil is suitable as a site for sewage lagoons if extra soil material can be hauled in and if grading can overcome the slope. Sealing the bottoms and sides of the lagoons with slowly permeable material helps to prevent seepage.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IIIs. The woodland ordination symbol is 3F.

66D—Doniphan cherty silt loam, 9 to 14 percent slopes. This deep, strongly sloping, well drained soil is on narrow, convex ridgetops and short, uneven side slopes in the uplands. Areas are irregular in shape and range from 10 to more than 100 acres in size.

Typically, the surface soil is very dark grayish brown and brown, very friable cherty silt loam about 13 inches thick. The subsoil extends to a depth of 67 inches or more. It is strong brown, friable cherty silty clay loam in the upper part; yellowish red, very firm clay in the next part; and red and yellowish brown, very firm clay and silty clay in the lower part.

Included with this soil in mapping are some areas of Bardley, Claiborne, and Goss soils. Bardley soils are 20 to 40 inches deep to limestone or dolomite bedrock and are in landscape positions similar to those of the Doniphan soil. Claiborne soils have less chert than the Doniphan soil. They are on the lower parts of the landscape near drainageways. Goss soils have more chert throughout than the Doniphan soil. They are on the steeper, lower side slopes. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Doniphan soil. Surface runoff is rapid. Available water capacity is low. Natural fertility and organic matter content also are low. The shrink-swell potential is moderate.

Most areas are used for pasture or timber. This soil is moderately suited to crownvetch, lespedeza, tall fescue, and most of the warm-season grasses commonly grown in the county. It generally is unsuited to hay because of chert fragments on the surface and the slope. Droughtiness, the erosion hazard, and the chert fragments in the surface layer are the main management concerns. Tillage should be avoided.

A few areas support native hardwoods. This soil is suited to trees. The use of planting equipment is restricted because of the chert in the surface layer. Hand planting may be necessary. No other hazards or limitations affect planting or harvesting.

This soil is suitable for building site development. The shrink-swell potential and the slope are limitations on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Land shaping or designing the buildings so that they conform to the natural slope of the land helps to overcome the slope. The moderate permeability is a limitation on sites for septic tank absorption fields. Enlarging the absorption field helps to overcome this limitation. Land shaping and installing the distribution lines across the slope help to prevent downhill seepage and improve the efficiency of the absorption system.

Also, the sewage generally can be piped to adjacent areas where the soil is better suited to onsite waste disposal.

Low strength, the shrink-swell potential, frost action, and the slope are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action. Some cutting and filling generally is necessary because of the slope.

The land capability classification is IVs. The woodland ordination symbol is 3F.

67C—Bardley cherty silt loam, 3 to 9 percent slopes. This moderately deep, gently sloping and moderately sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to more than 200 acres in size.

Typically, the surface soil is dark brown and yellowish brown, very friable cherty silt loam about 12 inches thick. The subsoil is about 21 inches thick. It is yellowish red, firm silty clay and red, very firm clay in the upper part and dark yellowish brown, very firm very gravelly clay in the lower part. The substratum is light brownish gray, firm cherty silty clay loam about 4 inches thick. Hard dolomite or limestone bedrock is at a depth of about 37 inches. In some areas the subsoil is yellowish brown. In some small areas the depth to hard bedrock is 40 to 60 inches.

Included with this soil in mapping are small areas of rock outcrop and small areas of Doniphan, Gasconade, Knobby, and Union soils. The deep Doniphan soils are on the upper parts of the landscape. The shallow Gasconade and very shallow Knobby soils are in steep areas and near isolated rock outcrop. The moderately well drained Union soils are on broad ridgetops. They have a fragipan. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Bardley soil. Surface runoff is rapid. Available water capacity is low. Organic matter content and natural fertility also are low. The rooting depth is restricted by the limestone bedrock at a depth of about 37 inches. The shrink-swell potential is moderate.

Most areas are used for timber or pasture. This soil is suitable for cropping on a limited basis but is generally not used for cultivated crops. It is well suited to most warm-season grasses and to birdsfoot trefoil and is moderately well suited to most cool-season grasses and legumes. The rooting depth is only moderate, and droughtiness is a problem during summer months. Tillage should be avoided. Erosion is a major concern if the pasture is tilled before it is seeded. A quickly established ground cover helps to prevent excessive soil loss.

Many areas support native hardwoods. This soil is suited to trees. Windthrow is a hazard. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight.

This soil is suited to building site development. The shrink-swell potential and the depth to bedrock are limitations on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. Because of the depth to bedrock, dwellings should be constructed without basements. Sewage lagoons can function adequately if the site can be leveled and if extra soil material is available for the berms and for sealing the bottoms of the lagoons. The soil generally is not suited to septic tank absorption fields.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IVe. The woodland ordination symbol is 2D.

67E—Bardley very cherty silt loam, 9 to 35 percent slopes. This moderately deep, strongly sloping to steep, well drained soil is on side slopes in the uplands. Areas range from 5 to more than 80 acres in size.

Typically, the surface layer is very dark grayish brown, very friable very cherty silt loam about 4 inches thick. The subsurface layer is yellowish brown, very friable very cherty silt loam about 4 inches thick. The subsoil is about 22 inches thick. The upper part is red and yellowish brown, very firm cherty silty clay loam. The lower part is red, yellowish red, and pale yellow, very firm clay and gravelly clay. Hard dolomite or limestone bedrock is at a depth of about 30 inches. In some areas the subsoil is yellowish brown. In some small areas the depth to hard bedrock is 40 to 60 inches. In other small areas the soil is not cherty.

Included with this soil in mapping are small areas of

rock outcrop, the deep Doniphan and Goss soils, and the shallow Gasconade and very shallow Knobby soils. Doniphan soils are on the upper parts of the landscape. Gasconade and Knobby soils are in areas next to rock outcrop. Goss soils are in the steeper areas. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Bardley soil. Surface runoff is rapid. Available water capacity is low. Organic matter content and natural fertility also are low. The rooting depth is restricted by the hard limestone bedrock. The shrink-swell potential is moderate.

Most areas are used for timber or pasture. This soil is well suited to most warm-season grasses and to birdsfoot trefoil and is moderately well suited to cool-season grasses and legumes. The rooting depth is only moderate, and droughtiness is a problem during summer months. Tillage should be avoided because of the rock fragments on the surface and the slope. Erosion is a major concern if the pasture is tilled before it is seeded. A quickly established ground cover helps to prevent excessive soil loss.

Many areas support native hardwoods. This soil is suited to trees. The erosion hazard, the equipment limitation, and windthrow are management concerns. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. The equipment limitation is moderate. Seedlings cannot be planted by machine in some areas because of the chert in the surface layer. On the steeper slopes, logging roads and skid trails should be built on the contour. In the steepest areas, it may be necessary to yard logs uphill to logging roads and skid trails.

This soil generally is unsuited to building site development and onsite waste disposal because of the slope.

The land capability classification is VIIe. The woodland ordination symbol is 2R.

68C—Eldon cherty silt loam, 3 to 9 percent slopes. This deep, gently sloping and moderately sloping, well drained soil is on ridges and convex side slopes in the uplands. Areas range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown, very friable cherty silt loam about 10 inches thick. The subsoil extends to a depth of 60 inches or more. It is reddish brown, friable very cherty silty clay loam and red, firm very cherty silty clay in the upper part and red, very firm clay in the lower part. In some areas the dark surface layer is thinner.

Included with this soil in mapping are small areas of Claiborne, Creldon, Goss, and McGirk soils. Claiborne and McGirk soils are not so cherty as the Eldon soil and are on the lower slopes. Creldon soils have a fragipan. They are on ridgetops above the Eldon soil. Goss soils have a light colored surface layer and are in the steeper areas. Also included are some areas of a soil that is grayer and less cherty throughout than the Eldon soil. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Eldon soil. Surface runoff is medium. Available water capacity is low or moderate. Organic matter content is moderate, and natural fertility is medium. The shrink-swell potential is moderate.

Most areas are used for pasture, hay, or small grain. Many areas support warm-season grasses. This soil is suitable for cropping on a limited basis but is generally not used for cultivated crops. It is well suited to grasses and legumes for pasture and hay. Insufficient soil moisture is common during summer months. Erosion and the chert fragments in the surface layer are problems. A system of minimum tillage that is applied in a timely manner helps to prevent serious soil loss.

This soil is suited to building site development. The shrink-swell potential is a limitation on sites for dwellings. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. The restricted permeability is a limitation on sites for septic tank absorption fields. Enlarged absorption fields can function adequately. The slope and seepage are limitations on sites for sewage lagoons. The sites should be leveled, and the bottoms and berms of the lagoons should be sealed with slowly permeable material.

Low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is IVs. No woodland ordination symbol is assigned.

68D—Eldon cherty silt loam, 9 to 14 percent slopes. This deep, strongly sloping, well drained soil is on side slopes in the uplands. Areas range from 5 to 80 acres in size.

Typically, the surface layer is very dark grayish brown, very friable cherty silt loam about 8 inches thick.

The subsurface layer is dark brown, very friable very cherty silty clay loam about 7 inches thick. The subsoil extends to a depth of 60 inches or more. It is dark brown, friable very cherty silty clay loam in the upper part; yellowish red, firm very cherty silty clay in the next part; and yellowish red, mottled, very firm clay in the lower part. In some areas the dark surface layer is thinner.

Included with this soil in mapping are small areas of Creldon, Goss, and McGirk soils. Creldon soils have a fragipan. They are on narrow ridgetops. Goss soils have a surface layer that is lighter colored than that of the Eldon soil. They are in the steeper areas. McGirk soils are grayer than the Eldon soil and are on the lower foot slopes. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Eldon soil. Surface runoff is rapid. Available water capacity is low or moderate. Organic matter content is moderate, and natural fertility is medium. The shrink-swell potential is moderate.

Most areas are used for hayland and pasture (fig. 6). Some areas support native warm-season grasses. This soil is moderately suited to crownvetch, lespedeza, tall fescue, and all of the warm-season grasses commonly grown in the county. Insufficient soil moisture is common during summer months. Erosion and the chert fragments in the surface layer are the main problems. A system of minimum tillage that is applied in a timely manner helps to prevent serious soil loss.

This soil is suited to building site development. The shrink-swell potential and the slope are limitations. Constructing the foundations and footings with adequately reinforced concrete helps to prevent the structural damage caused by shrinking and swelling. The slope can be overcome by land shaping or by designing the buildings so that they conform to the natural slope of the land. The restricted permeability and the slope are limitations on sites for septic tank absorption fields. Enlarging the absorption fields helps to overcome the restricted permeability. Land shaping and installing the distribution lines on the contour help to prevent downhill seepage. The soil generally is not suited to sewage lagoons because of the slope and seepage.

Low strength, the shrink-swell potential, frost action, and the slope are limitations on sites for local roads and streets. Crushed rock or other suitable material helps to prevent the road damage caused by low strength. Grading the roads and streets so that they shed water, constructing adequate roadside ditches, and installing culverts improve drainage and thus minimize the damage caused by shrinking and swelling and by frost action. Some cutting and filling is necessary because of the slope.

The land capability classification is VIs. No woodland ordination symbol is assigned.

72C—Gasconade-Rock outcrop complex, 2 to 9 percent slopes. This map unit occurs as areas of a shallow, gently sloping and moderately sloping, somewhat excessively drained Gasconade soil intermingled with areas of Rock outcrop. The unit is on isolated ridgetops, in saddles, and on side slopes. Areas are irregular in shape and range from 5 to more than 80 acres in size. They are about 65 percent Gasconade soil and 25 percent Rock outcrop.

Typically, the surface layer of the Gasconade soil is black, friable flaggy silty clay loam about 8 inches thick. The subsoil is dark brown, firm very flaggy silty clay loam about 7 inches thick. Hard limestone or dolomite bedrock is at a depth of about 15 inches.

The Rock outcrop is exposed limestone or dolomite bedrock. As much as 3 inches of soil material covers the bedrock in places.

Included with the Gasconade soil and Rock outcrop in mapping are small areas of the well drained Bardley and Doniphan soils and the very shallow Knobby soils. Bardley and Doniphan soils are around the edges of the mapped areas. Knobby soils are in landscape positions similar to those of the Gasconade soil. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Gasconade soil. Surface runoff is rapid. Available water capacity is very low. Organic matter content is moderate, and natural fertility is low. The rooting depth is restricted by the hard bedrock.

Most areas are pastured or wooded. Some support dense stands of eastern redcedar and post oak. The Gasconade soil is droughty. Alsike clover, big and little bluestem, and indiangrass are the best suited forage species. The high content of coarse fragments in the surface layer and the Rock outcrop limit the use of equipment.

The Gasconade soil is poorly suited to hardwood trees because of the shallowness to bedrock. Eastern redcedar is the best suited timber species. Because of low production, timber management generally is not feasible. The equipment limitation, seedling mortality, and the windthrow hazard are management concerns. They cannot be easily overcome.

The Gasconade soil has poor potential as habitat for most types of upland game. The native grasses and eastern redcedar on this soil, however, provide food

Figure 6.—Improved pasture in an area of Eldon cherty silt loam, 9 to 14 percent slopes.

and cover for some wildlife species.

The Gasconade soil generally is unsuitable for building site development and onsite sewage disposal because of the shallowness to bedrock.

The land capability classification is VIs. The woodland ordination symbol assigned to the Gasconade soil is 2D. No woodland ordination symbol is assigned to the Rock outcrop.

72F—Gasconade-Rock outcrop complex, 9 to 50 percent slopes. This map unit occurs as areas of a shallow, strongly sloping to very steep, somewhat

excessively drained Gasconade soil intermingled with areas of Rock outcrop. The unit is on bluffs and in steep areas adjacent to streams. Areas are irregular or linear in shape and range from 5 to more than 200 acres in size. They are about 60 percent Gasconade soil and 30 percent Rock outcrop.

Typically, the surface layer of the Gasconade soil is very dark grayish brown, friable flaggy silty clay loam about 3 inches thick. The subsoil is very dark grayish brown, firm very flaggy silty clay loam about 4 inches thick. The substratum is dark brown, firm very flaggy silty clay loam about 7 inches thick. Hard limestone bedrock is at a depth of about 14 inches.

The Rock outcrop is exposed limestone or dolomite bedrock. As much as 3 inches of soil material covers the bedrock in places.

Included with the Gasconade soil and Rock outcrop in mapping are small areas of the well drained, moderately deep Bardley soils. These soils are around the edges of the mapped areas. Also included are areas of the very shallow Knobby soils, which are in landscape positions similar to those of the Gasconade soil. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Gasconade soil. Surface runoff is rapid. Available water capacity is very low. Organic matter content is moderate, and natural fertility is low. The surface layer is friable; however, it cannot be easily tilled because it is flaggy. The rooting depth is restricted by the hard bedrock.

Most areas are pastured or wooded. The Gasconade soil is droughty. Alsike clover, big and little bluestem, and indiangrass are the best suited forage species. The high content of coarse fragments in the surface layer, the slope, and the Rock outcrop limit the use of equipment.

The Gasconade soil is poorly suited to hardwood trees because of the shallowness to bedrock. Eastern redcedar is the best suited timber species. Because of low production, timber management generally is not feasible. The equipment limitation, seedling mortality, and the windthrow hazard are management concerns. They cannot be easily overcome.

The Gasconade soil has poor potential as habitat for most types of upland game. The native grasses and eastern redcedar on this soil, however, provide food and cover for some wildlife species.

The Gasconade soil generally is unsuitable for building site development and onsite sewage disposal because of the slope and the shallowness to bedrock.

The land capability classification is VIIs. The woodland ordination symbol assigned to the Gasconade soil is 2R. No woodland ordination symbol is assigned to the Rock outcrop.

74C—Knobby-Rock outcrop complex, 3 to 9 percent slopes. This map unit occurs as areas of a very shallow, gently sloping and moderately sloping, well drained Knobby soil intermingled with areas of Rock outcrop. The unit is on isolated grassy glades, on ridgetops, in saddles, and on side slopes in the uplands. Areas are irregular in shape and range from 5 to more than 30 acres in size. They are about 65 percent Knobby soil and 20 percent Rock outcrop.

Typically, the surface layer of the Knobby soil is very dark gray, very friable gravelly loam about 3 inches thick. The subsurface layer is very dark gray, very friable very gravelly sandy loam about 4 inches thick. Hard dolomite bedrock is at a depth of about 7 inches. In places the soil is sandy loam throughout.

The Rock outcrop is exposed dolomite bedrock. As much as 3 inches of soil material covers the bedrock in places.

Included with the Knobby soil and Rock outcrop in mapping are small areas of the moderately deep Bardley and shallow Gasconade soils. These soils are around the edges of the mapped areas. They make up about 15 percent of the unit.

Permeability is moderate in the Knobby soil. Surface runoff is medium. Available water capacity is very low. Organic matter content is moderately low, and natural fertility is low. The surface layer is friable; however, it cannot be easily tilled because of the stoniness. The rooting depth is restricted by the hard bedrock.

Most areas are pastured. Some areas support a few scattered eastern redcedar and scrub oak trees. Others support only native warm-season grasses. The Knobby soil is poorly suited to hay and pasture. The very gravelly surface layer and the Rock outcrop limit the use of equipment.

The Knobby soil generally is unsuitable for building site development and onsite waste disposal because of the shallowness to bedrock.

The land capability classification is VIs. The woodland ordination symbol assigned to the Knobby soil is 2F. No woodland ordination symbol is assigned to the Rock outcrop.

74F—Knobby-Rock outcrop complex, 9 to 50 percent slopes. This map unit occurs as areas of a very shallow, strongly sloping to steep, well drained Knobby soil intermingled with areas of Rock outcrop. The unit is on the side slopes of isolated grassy glades in the uplands. Areas are irregular in shape and range

from 5 to more than 100 acres in size. They are about 70 percent Knobby soil and 20 percent Rock outcrop.

Typically, the surface layer of the Knobby soil is very dark grayish brown, very friable gravelly loam about 5 inches thick. The subsurface layer is very dark grayish brown, very friable very gravelly loam about 3 inches thick. Hard dolomite bedrock is at a depth of about 8 inches. In some areas the soil has more clay.

The Rock outcrop is exposed dolomite bedrock. As much as 3 inches of soil material covers the bedrock in places.

Included with the Knobby soil and Rock outcrop in mapping are small areas of the moderately deep Bardley and shallow Gasconade soils. These soils are around the edges of the mapped areas. They make up about 10 percent of the unit.

Permeability is moderate in the Knobby soil. Surface runoff is rapid. Available water capacity is very low. Organic matter content is moderately low, and natural fertility is low. The surface layer is friable; however, it cannot be easily tilled because of the stoniness. The rooting depth is restricted by the hard bedrock.

Most areas are pastured. Some areas support a few scattered eastern redcedar and scrub oak trees. Others support only native warm-season grasses. The Knobby soil is poorly suited to hay and pasture. The slope and the Rock outcrop limit the use of equipment.

The Knobby soil generally is unsuitable for building site development and onsite waste disposal because of the shallowness to bedrock.

The land capability classification is VIIs. The woodland ordination symbol assigned to the Knobby soil is 2F. No woodland ordination symbol is assigned to the Rock outcrop.

80—Osage silty clay loam. This deep, nearly level, poorly drained soil is in low areas on wide flood plains along the Osage and Pomme de Terre Rivers. It is occasionally flooded. Areas are linear in shape and range from 20 to more than 100 acres in size.

Typically, the surface layer is black, friable and firm silty clay loam about 8 inches thick. The subsurface layer is black, very firm silty clay about 16 inches thick. The subsoil to a depth of 60 inches or more is very firm silty clay. It is very dark gray and dark gray in the upper part and dark gray and mottled in the lower part.

Included with this soil in mapping are areas of the moderately well drained Verdigris soils on narrow flood plains. These soils are browner and less clayey than the Osage soil. They make up about 5 to 10 percent of the unit.

Permeability is very slow in the Osage soil. Surface runoff also is very slow. Available water capacity is moderate. Organic matter content also is moderate, and natural fertility is high. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. A seasonal high water table is within a depth of 1 foot during most winter and spring months. The shrink-swell potential is very high.

Most areas support grasses for hay and pasture. This soil is suited to soybeans, grain sorghum, small grain, grasses, and legumes. Species of shallow-rooted grasses and legumes that are tolerant of wetness should be selected for planting on hayland and pasture. Restricted use during wet periods, proper stocking rates, and a system of pasture rotation that includes scheduled rest periods help to restrict the growth of weeds and prevent surface compaction.

If this soil is used for cultivated crops, tillage may be delayed in the spring because of the wetness. Yields are reduced by water standing in potholes and by flooding. A drainage system and timely tillage are needed.

This soil is suited to trees. Species that are tolerant of wetness, such as cottonwood and pecan, should be selected for planting. Seedling mortality, the windthrow hazard, and the equipment limitation are management concerns. Ridging the soil and then planting on the ridges can increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. Trees should be planted and harvested during periods when the soil is firm enough to support vehicular traffic.

This soil generally is unsuitable for building site development and onsite waste disposal because of the occasional flooding and the wetness.

The land capability classification is IIIw. The woodland ordination symbol is 4W.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food,

feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 134,600 acres in Benton County, or nearly 30 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in associations 1, 2, and 5, which are described in the section "General Soil Map Units." Crops grown on this land, mainly corn, grain sorghum, wheat, and soybeans, account for about two-thirds of the county's total agricultural income each year *(18)*.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to recreational uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in Benton County that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About half of the acreage in the county is used for crops and pasture. In 1977, about 16 percent of the land area was used for crops, including hay *(8)*. Corn, soybeans, winter wheat, and grain sorghum are the principal cultivated crops. Most areas that are not woodland or cropland have a cover of grasses and legumes and are grazed. Most of the cropland and much of the woodland are also grazed at some time during the average year. Tall fescue, warm-season grasses, orchardgrass, alfalfa, lespedeza, red clover, and sudangrass are the major forage plants.

The major management needs on the cropland and pasture in the survey area are measures that control water erosion, conserve moisture, reduce wetness, and help to maintain fertility and tilth. A combination of measures is needed in most areas.

High fertility levels increase the yields of grain and forage. The kind and amount of soil amendments needed to maintain or increase fertility levels can be determined by soil tests. A complete record of the kind and amount of fertilizer applied, the time amendments were made, and the yields obtained is desirable. Leaving large amounts of crop residue on the surface after harvest can increase the organic matter content and keep the soil porous, thereby increasing the rate of water infiltration and the available water capacity.

Leaving residue on the surface also can help to control runoff and water erosion. The effectiveness of this measure depends on the amount of residue and the

Figure 7.—No-till soybeans planted in wheat stubble in an area of Hartwell soils.

length of time that it is left on the surface. Plowing in the spring, which allows residue to remain on the surface throughout the winter, is more effective than plowing in the fall, which leaves the surface bare.

No-till farming and other conservation tillage systems help to maintain good tilth, increase the rate of water infiltration, and reduce the hazard of water erosion (fig. 7). In areas where such systems are applied, chisel plows and disk or field cultivators are used and at least 30 percent of the surface is covered by crop residue after planting.

If special management is applied, some soils can be cultivated year after year without excessive water erosion. These include soils on bottom land and some of the nearly level soils on uplands. Intensive cropping generally requires measures that maintain fertility, management of crop residue, and no-till farming or minimum tillage.

Grassed waterways are effective in controlling water erosion in areas where runoff accumulates in natural drainageways. Natural or constructed grassed waterways can serve as outlets in terraced areas. Waterways can be designed so that they can be crossed by large farm machinery. In areas of Barden, Creldon, Eldon, Hartwell, and other soils that are shallow or moderately deep to a clayey subsoil or to rocky layers, topsoil should be stockpiled and then spread over the waterway after it has been shaped.

Terraces reduce the length of slopes and thus are effective in controlling water erosion, especially on the more sloping cultivated soils. A combination of terraces and contour farming generally is needed on cultivated soils with slopes of more than 2 percent or with slopes of less than 2 percent that are more than 120 feet long. A system of terraces that are nearly parallel to each other is preferable because it eliminates excessive point rows and makes farming more convenient.

In some areas of Hartwell, Quarles, and Barden

soils, farming up and down the slope has resulted in severely eroded strips that start near the top of the ridge or near fences or roads and continue downslope for about 700 to 800 feet. These strips are several hundred feet wide. Sheet erosion can be controlled in these areas by a crop rotation that includes small grain or meadow crops, no-till farming or another conservation tillage system, or contour farming. In places it can be controlled by terracing.

A drainage system and flood control are needed on about 6 percent of the acreage used for crops and pasture in the county. Moniteau, Osage, and Quarles soils are naturally so wet that crop production is reduced during some parts of the year. Occasional flooding can hinder crop production on Ashton, Osage, Quarles, Racket, and Verdigris soils. The flooding on these soils commonly occurs during the period November through April.

Many good stands of high-yielding pasture grasses and legumes have been established in the county. Pasture renovation and improved management are needed to protect the soil from erosion in these areas (fig. 8).

Proper management measures help to establish good pastures. Examples are applying lime and fertilizer as recommended by current soil tests; preparing clean, firm seedbeds; timely planting of only the adapted species of grasses and legumes; planting the recommended amount of seeds and covering them with ¼ to ½ inch of soil; inoculating all legume seeds with proper bacteria within 24 hours of planting; controlling weeds until new seedlings are well established; and deferring grazing in newly planted areas until root systems are thoroughly established.

Proper management of permanent pasture increases the life of the stand, maintains the quality and quantity of the forage, protects the soil against erosion, and reduces water loss. Some important management practices are using proper stocking rates; maintaining a minimum grazing height; applying plant nutrients for healthy, vigorous growth; and allowing rest periods during the grazing season and prior to frost in the fall. Other factors are weed control, water distribution, and rotation grazing.

A well managed pasture generally includes mixtures of cool-season grasses and legumes, which can be grazed during spring and fall. Tall fescue can be fed to livestock in the winter. Surplus grasses and legumes produced in the spring can be round-baled and left in the field to extend the grazing season and maintain feed quality. Native warm-season grasses grow in some areas of Creldon and Eldon soils. Good-quality summer forage includes warm-season grasses, such as bluestem, indiangrass, and switchgrass. Prescribed burning can help to control undesirable vegetation and improve the quality and quantity of warm-season grasses, but it generally is necessary only once every 3 to 5 years. A pasture should be burned only when a specific management objective is to be met.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for

Figure 8.—A gully in an overgrazed area of Bardley soils.

field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit *(15)*. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations or hazards that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have

limitations that nearly preclude their use for commercial crop production. There are no class I, class V, or class VIII soils in Benton County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

Approximately 42 percent of the land area in Benton County is forested *(8)*. Nearly all of the woodland is commercial forest.

An understanding of soils helps to explain how forest types develop and tree growth occurs. For example, white oak grows well on deep, moist soils, and hickories, post oak, and chinkapin oak are more prevalent where the rooting depth is restricted or the moisture supply is limited. The soil serves as a reservoir for moisture, provides an anchor for roots, and supplies most of the available plant nutrients. The soil properties that directly or indirectly affect these growth requirements include reaction, fertility, drainage, texture, structure, and depth. Landscape position also is important.

Available water capacity is primarily influenced by texture, rooting depth, and content of stones, shale, and chert. Deep silt loams, such as Racket silt loam, have a high available water capacity and a high potential for the production of trees. The content of flagstones and the depth to bedrock reduce the amount of available water and restrict the rooting depth in Gasconade and other soils. Because of these limitations, the potential for trees is low. Although little can be done to overcome these limitations, planting the species most suited to the soils helps to maximize woodland productivity.

The supply of plant nutrients in the soil affects tree growth. The role of the mineral horizons is important. Many upland soils have a subsoil that is leached and thus contains few nutrients. Most soils on bottom land have a substratum that contains larger amounts of nutrients than is characteristic of the upland soils.

Decomposition of a layer of leaf litter on the surface recycles the nutrients that have accumulated in the forest ecosystem over long periods. Fire, excessive trampling by livestock, and erosion can result in loss of these nutrients and in reduced productivity on the site. Forest management should include fire prevention and protection from overgrazing.

Among the site characteristics that affect tree growth are aspect and position on the landscape. These characteristics influence such factors as the amount of available sunlight, air drainage, soil temperature, and moisture relations. Because of these factors, north- and east-facing slopes generally are the best upland sites for tree growth.

The Hartwell-Barden and Eldon-Creldon-Barden associations, which are described under the heading "General Soil Map Units," consist dominantly of prairie soils and have a very small acreage of woodland. The woodland is generally along the drainageways and in the more sloping areas.

The Bardley-Gasconade-Goss and Goss-Bardley-Doniphan associations typically support the oak-hickory forest type. Eastern redcedar typically is the predominant species on the Gasconade soil. Other common species are white ash, chinkapin oak, post oak, hackberry, winged elm, blackjack oak, pignut hickory, and black hickory. Post oak, chinkapin oak, white oak, black oak, eastern redcedar, and white ash are common species on the Bardley soils. Timber stands with some potential for management occur primarily on favorable north-northeast aspects, whereas south-facing slopes are not productive timber sites.

The Goss and Doniphan soils support white oak, northern red oak, black oak, post oak, white ash, and walnut. These stands have good potential for management and growth of timber. Grazing and burning in the past have affected the quality and species composition of many of the stands. Proper management can restore the productive capabilities of these sites.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each suitable soil.

Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 through 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; and *L*, low strength. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and L.

In table 7, *slight*, *moderate*, and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is greater than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant

species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

In 1980, Benton County had 165,578 acres of recreational developments *(13)*. About 96 percent of this acreage was federally owned. The rest was divided among state, private, municipal, county, school, and other local entities. The facilities included swimming areas, hunting and fishing areas, camping areas, trails, game courts, ball fields, picnic areas, play areas, historical sites, and wildlife-viewing areas. A 1976 report projected a 48.7 percent increase in the population of the county by 1990 *(7)*. This increase will result in a demand for more recreational facilities.

The Truman Reservoir, which includes 29,062 acres of land and 34,250 acres of water within the county, greatly enhances the recreational resources of this region. A recreation development plan for the reservoir calls for the creation of 13 public parks. The parks will include complete campground facilities; 8 swimming beaches; 18 boat-launching sites, including 7 marina concessions; natural areas; a visitor center; picnic facilities; ball fields; and sites for water sports. Various aquatic habitat developments are planned to improve the lake's fishery. Hunting will be allowed on all government-owned lands, except for park areas and sites posted for security and safety purposes.

Other recreation areas in the county include the Lake of the Ozarks, the state-owned Big Buffalo Creek and Mora Prairie Wildlife Areas, and several smaller public facilities. A 1974 inventory identified 11 private and semiprivate commercial recreation enterprises in the county *(10)*. These enterprises included a golf course, a scout camp, marinas, small resorts, and a campground.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

Benton County is among the 13 counties in Missouri that make up the West Ozark Border Zoogeographic Region *(9)*. Approximately 13 percent of the county is used for cultivated crops; 35 percent for grassland; and 42 percent for woodland, which includes areas of small shrubs and brush.

This land-use distribution favors both openland and woodland wildlife. Deer and turkey are the most popular game species in the county. The population of nongame wildlife, such as songbirds, is rated good to excellent in each of the associations described under the heading "General Soil Map Units."

The population of the county is expected to increase by about 48.7 percent by the year 1990 *(7)*. An increase in the extent of urban development is expected to have a negative effect on wildlife. Other potential problems associated with wildlife habitat include a monoculture of fescue grass and the loss of wooded fence rows between fields in the northern half of the county.

The Goss-Bardley-Doniphan and Bardley-Gasconade-Goss associations include most of the woodland in the county. These two associations, along with the timbered portions of the other associations, provide the primary habitat for the county's woodland wildlife. The deer population is excellent (fig. 9). The carrying capacity for this big game animal has nearly been reached. The turkey population is good and is increasing. Both deer and turkey are heavily hunted. Depending on mast production, squirrel numbers are generally good. The county has a small resident population of woodcock in special habitats. Migratory flights of this species into the area are minor.

The furbearer population is good throughout the county. A decline in fur prices has somewhat reduced the extent of trapping. Raccoon, opossum, coyote, muskrat, red and gray fox, beaver, and mink are the principal species trapped. There is a fair bobcat population in the county.

Limited numbers of prairie species inhabit the few remaining grassland areas that meet their strict habitat requirements. Species include prairie chicken, upland plover, marsh hawks, and a few badgers.

The Hartwell-Barden, Eldon-Creldon-Barden, and Barden-Barco-Deepwater associations provide the primary habitat for the county's openland wildlife species. The important grain crops are grain sorghum, soybeans, winter wheat, and corn. Fall plowing, which can harm the habitat, occurs on about 50 percent of the cropland. Fall chisel plowing and conservation tillage systems, both of which leave grain and crop residue on the surface after harvest, provide additional winter food and a limited amount of cover for wildlife. Numbers of bobwhite quail are poor. The breeding population has not yet recovered from past severe winters, which killed many birds in this age class. The county has some good quail habitat, and the population of this bird probably will be replenished. The rabbit population is only fair. The northern half of the county has a fair population of mourning doves.

Figure 9.—Deer in a timbered area of the Goss-Bardley-Doniphan association.

The county has almost no wetland habitat. Mudflats and sloughs along the Lake of the Ozarks and the Osage River provide the only remaining permanent wetlands. The Truman Reservoir provides some public wetland areas, but fluctuating water levels reduce the quality of the habitat. Ducks and geese frequent the Lake of the Ozarks and portions of the Truman Reservoir. The extent of wood duck habitat has increased as a result of the reservoir. Overall, waterfowl populations are low. Six to twelve heron rookeries have been identified in the county over the past few years.

Fishing opportunities are provided by the two major lakes, a few creeks, and farm ponds. Many fishing streams were inundated by the reservoir. The remaining streams contain largemouth bass, channel catfish, bullheads, suckers, and bluegills and other sunfish.

The Truman Reservoir and the Lake of the Ozarks provide the general public opportunities for impoundment fishing. The Truman Reservoir is by far the larger of the two. The most popular species include striped bass, walleye, largemouth bass, channel and flathead catfish, paddlefish, and sunfish. Approximately 1,200 private farm ponds and small lakes in the county have been stocked with largemouth bass, channel catfish, and bluegill.

Soils affect the kind and amount of vegetation that is

available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl-feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the

depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1

or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate

shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment.

Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce water and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts and sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

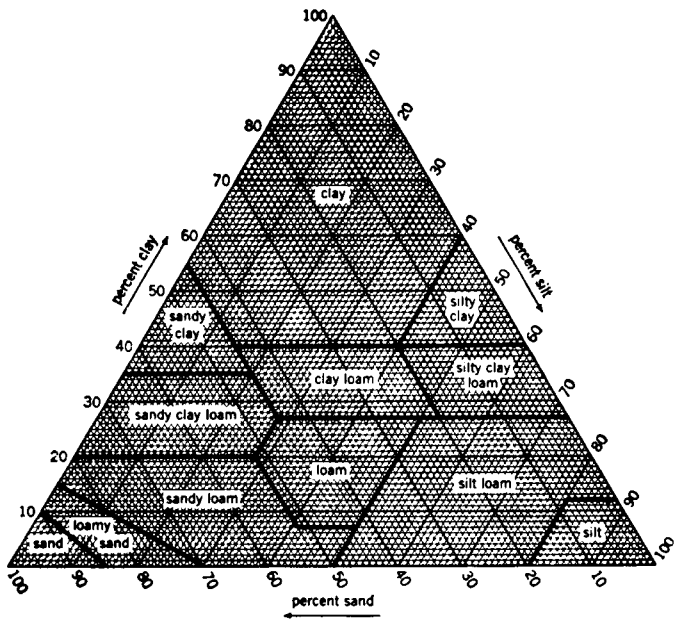

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and

highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and

is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff

from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very

gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(16)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalf (*Ud*, meaning humid, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Paleudalfs (*Pale*, meaning old, plus *udalf*, the suborder of the Alfisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Paleudalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is clayey-skeletal, mixed, mesic Typic Paleudalfs.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (14)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (16)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Ashton Series

The Ashton series consists of deep, well drained,

moderately permeable soils on low stream terraces. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Ashton silt loam, 2,200 feet east and 500 feet north of the southwest corner of sec. 29, T. 39 N., R. 21 W.

Ap—0 to 6 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; common fine roots; neutral; abrupt smooth boundary.
A—6 to 10 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; common fine roots; slightly acid; abrupt smooth boundary.
Bt1—10 to 16 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine subangular blocky structure; friable; common fine roots; few worm casts; few faint clay films; common fine silt coatings; medium acid; clear smooth boundary.
Bt2—16 to 29 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine subangular blocky structure; friable; few fine roots; common distinct clay films; many fine silt coatings; medium acid; clear smooth boundary.
Bt3—29 to 49 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; few fine roots; common distinct clay films; many fine silt coatings; medium acid; clear smooth boundary.
C—49 to 60 inches; dark brown (10YR 4/3), dark yellowish brown (10YR 4/4), and strong brown (7.5YR 5/6) silt loam; massive; friable; many pores; slightly acid.

The thickness of the solum ranges from 40 to 60 inches. The content of pebbles is 0 to 5 percent in the solum and 0 to 10 percent in the C horizon.

The A horizon has hue of 10YR or 7.5YR and chroma of 2 or 3. It typically is silt loam, but the range includes loam and fine sandy loam. The Bt horizon has hue of 10YR to 5YR, value of 3 to 5, and chroma of 3 to 6. The C horizon has hue, value, and chroma similar to those of the Bt horizon. It is silt loam, loam, or fine sandy loam.

Barco Series

The Barco series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in acid sandstone residuum. Slopes range from 2 to 9 percent.

Typical pedon of Barco loam, 2 to 5 percent slopes, 1,600 feet west and 1,000 feet south of the northeast corner of sec. 7, T. 42 N., R. 23 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many fine roots; neutral; abrupt smooth boundary.
A—8 to 13 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; common fine roots; few worm channels and casts; slightly acid; clear smooth boundary.
Bt1—13 to 17 inches; dark yellowish brown (10YR 3/4) clay loam; weak fine subangular blocky structure; friable; few fine roots; few worm channels and casts; common distinct clay films; dark brown (10YR 3/3) streaks; strongly acid; clear smooth boundary.
Bt2—17 to 26 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; friable; few fine roots; common distinct clay films; strongly acid; clear smooth boundary.
Cr1—26 to 33 inches; soft sandstone bedrock with lenses of brownish yellow (10YR 6/8) clay loam; abrupt smooth boundary.
Cr2—33 to 60 inches; soft sandstone bedrock.

The thickness of the solum and the depth to soft sandstone bedrock range from 20 to 40 inches. The A horizon has hue of 7.5YR or 10YR and value and chroma of 2 or 3. It typically is loam, but the range includes silt loam. The Bt horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 to 8. It is loam, sandy clay loam, or clay loam.

Barden Series

The Barden series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess or silty material and shale residuum. Slopes range from 1 to 5 percent.

Typical pedon of Barden silt loam, 1 to 5 percent slopes, 100 feet south and 2,440 feet east of the northwest corner of sec. 13, T. 43 N., R. 23 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; few fine concretions of iron and manganese oxides; medium acid; abrupt smooth boundary.
A—7 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; few fine concretions of iron and manganese oxides;

slightly acid; clear smooth boundary.
BA—11 to 14 inches; dark brown (10YR 4/3) silty clay loam; few medium faint dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; friable; many fine and very fine roots; few fine concretions of iron and manganese oxides; medium acid; clear smooth boundary.
Bt1—14 to 23 inches; dark grayish brown (10YR 4/2) silty clay; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; very firm; common fine roots; many distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; slightly acid; clear smooth boundary.
Bt2—23 to 30 inches; dark grayish brown (10YR 4/2) silty clay loam; few coarse faint light brownish gray (10YR 6/2) and few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; very firm; common fine roots; many distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; slightly acid; clear smooth boundary.
Bt3—30 to 34 inches; dark brown (10YR 4/3) silty clay loam; many coarse distinct gray (10YR 6/1) and many fine distinct dark yellowish brown (10YR 4/6) mottles; weak medium platy structure parting to weak fine subangular blocky; friable; few fine roots; few distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; few fine chert fragments; slightly acid; clear smooth boundary.
C—34 to 60 inches; light yellowish brown (10YR 6/4) silty clay loam; many coarse distinct gray (10YR 6/1) mottles; massive; friable; few fine roots; few vertical cracks; many root pores; few distinct clay films in cracks and root pores; slightly acid.

The thickness of the solum ranges from 30 to 60 inches. The depth to shale bedrock is more than 60 inches. The base saturation is less than 50 percent in some part of the argillic horizon.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It typically is silt loam, but the range includes silty clay loam. The BA horizon has value and chroma of 3 or 4. The Bt horizon has value of 4 or 5 and chroma of 2 to 6. The C horizon is silty clay loam or clay loam.

Bardley Series

The Bardley series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in cherty sediments and dolomite and limestone residuum. Slopes range from 3 to 35 percent.

Typical pedon of Bardley very cherty silt loam, 9 to 35 percent slopes, 600 feet west and 800 feet north of the southeast corner of sec. 12, T. 40 N., R. 20 W.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) very cherty silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; 40 percent chert fragments; slightly acid; abrupt wavy boundary.
E—4 to 8 inches; yellowish brown (10YR 5/4) very cherty silt loam; weak fine granular structure; very friable; many medium and fine roots; 40 percent chert fragments; few sandstone flagstones; medium acid; abrupt wavy boundary.
BE—8 to 10 inches; red (2.5YR 5/8) and yellowish brown (10YR 5/4) cherty silty clay loam; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; very firm; many medium and fine roots; 30 percent chert fragments; few sandstone flagstones; dark grayish brown (10YR 4/2) silt coatings on faces of peds; strongly acid; abrupt wavy boundary.
Bt1—10 to 22 inches; red (2.5YR 4/6) clay; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; very firm; many coarse roots; many prominent clay films on faces of peds; 10 percent chert fragments; very strongly acid; clear irregular boundary.
Bt2—22 to 30 inches; yellowish red (5YR 4/6) and pale yellow (2.5Y 7/4) gravelly clay; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; very firm; common coarse roots; many prominent clay films; 30 percent dolomite fragments; neutral; abrupt irregular boundary.
R—30 inches; hard dolomite bedrock.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The content of chert or flagstone fragments in the surface layer ranges from 15 to 70 percent.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. It typically is very cherty silt loam, but the range includes cherty silt loam. The Bt horizon has hue of 10R, 2.5YR, or 5YR, value of 3 to 5, and chroma of 4 to 6.

Bolivar Series

The Bolivar series consists of moderately deep, well drained, moderately permeable soils on uplands. These

soils formed in acid sandstone residuum. Slopes range from 5 to 14 percent.

Typical pedon of Bolivar fine sandy loam, 5 to 9 percent slopes, 1,020 feet south and 100 feet east of the northwest corner of sec. 31, T. 41 N., R. 23 W.

Ap—0 to 8 inches; brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; many fine roots; few fine concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

BA—8 to 11 inches; strong brown (7.5YR 4/6) clay loam; weak fine subangular blocky structure; friable; common worm channels and few fine worm casts; many fine roots; few fine sandstone fragments; medium acid; clear smooth boundary.

Bt1—11 to 17 inches; strong brown (7.5YR 4/6) clay loam; few fine distinct dark yellowish brown (10YR 4/6) and few fine prominent brown (10YR 5/3) mottles; weak fine subangular blocky structure; friable; many fine roots; few distinct clay films on faces of peds; very strongly acid; gradual smooth boundary.

Bt2—17 to 26 inches; dark yellowish brown (10YR 4/4) clay loam; many medium faint brown (10YR 5/3) and few fine prominent red (2.5YR 4/6) mottles; weak fine subangular blocky structure; friable; few fine roots; few prominent clay films on faces of peds; very strongly acid; clear smooth boundary.

Cr1—26 to 30 inches; soft sandstone with thin layers of clay loam; few fine roots; strongly acid; abrupt smooth boundary.

Cr2—30 to 60 inches; soft sandstone bedrock.

The thickness of the solum ranges from 20 to 40 inches and generally is the same as the depth to weathered sandstone bedrock. The depth to hard bedrock is more than 40 inches. Fragments of weathered sandstone make up less than 35 percent of the soil mass of any horizon.

The Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. Some pedons have an E horizon. This horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is fine sandy loam or loam. The Bt horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5, and chroma of 4 to 8. It is loam, sandy clay loam, or clay loam.

Claiborne Series

The Claiborne series consists of deep, well drained, moderately permeable soils on foot slopes and side slopes along stream valleys. These soils formed in local colluvium or cherty limestone residuum. Slopes range from 5 to 9 percent.

Typical pedon of Claiborne silt loam, 5 to 9 percent slopes, 520 feet south and 2,620 feet east of the northwest corner of sec. 22, T. 39 N., R. 20 W.

Ap—0 to 6 inches; dark brown (10YR 3/3) silt loam, light yellowish brown (10YR 6/4) dry; weak fine granular structure; very friable; many fine roots; 5 percent chert fragments; strongly acid; clear smooth boundary.

A—6 to 10 inches; dark yellowish brown (10YR 3/4) silt loam; weak thin platy structure parting to weak fine granular; very friable; common fine roots; few distinct worm casts; 2 percent chert fragments; strongly acid; clear smooth boundary.

BA—10 to 16 inches; reddish brown (5YR 4/4) silty clay loam; weak fine subangular blocky structure; friable; common fine roots; common distinct worm casts; very strongly acid; clear smooth boundary.

Bt1—16 to 24 inches; yellowish red (5YR 4/6) silty clay loam; weak medium blocky structure parting to weak fine subangular blocky; friable; few fine roots; few distinct clay films on faces of peds; 5 percent chert fragments; common prominent worm casts; very strongly acid; gradual smooth boundary.

Bt2—24 to 40 inches; yellowish red (5YR 4/6) silty clay loam; moderate fine subangular blocky structure; friable; few fine roots; many prominent clay films on faces of peds; 5 percent chert fragments; very strongly acid; gradual smooth boundary.

Bt3—40 to 60 inches; yellowish red (5YR 4/6) silty clay loam; common medium prominent light gray (5YR 7/1) mottles; moderate medium angular blocky structure; friable; many prominent clay films on faces of peds; 5 percent chert fragments; black iron and manganese stains on faces of some peds; very strongly acid.

The solum is more than 60 inches thick. The content of angular chert fragments ranges from 5 to 25 percent in the Bt horizon.

The A horizon has chroma of 2 to 4. The Bt horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 3 to 5, and chroma of 4 to 8. It is silty clay loam or cherty silty clay loam.

Creldon Series

The Creldon series consists of deep, moderately well drained soils on uplands. These soils have a fragipan.

They formed in loess and loamy or clayey cherty limestone residuum. Permeability is moderately slow above the fragipan, very slow in the fragipan, and moderately rapid below the fragipan. Slopes range from 2 to 9 percent.

Typical pedon of Creldon silt loam, 2 to 5 percent slopes, 1,885 feet south and 50 feet west of the northeast corner of sec. 10, T. 43 N., R. 21 W.

A1—0 to 10 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; many fine roots; few fine chert fragments; neutral; clear smooth boundary.

A2—10 to 14 inches; dark brown (10YR 3/3) silt loam; weak fine granular structure; very friable; many fine roots; few fine chert fragments; neutral; clear smooth boundary.

Bt1—14 to 20 inches; yellowish brown (10YR 5/6) silty clay loam; common fine prominent yellowish red (5YR 5/8) mottles; weak fine subangular blocky structure; friable; many fine roots; few faint clay films on faces of peds; few fine concretions of iron and manganese oxides; few fine chert fragments; medium acid; clear wavy boundary.

Bt2—20 to 26 inches; mottled grayish brown (10YR 5/2), yellowish brown (10YR 5/8), and dark reddish brown (2.5YR 3/4) silty clay loam; weak fine subangular blocky structure; friable; common fine roots; many prominent clay films on faces of peds; few fine concretions of iron and manganese oxides; medium acid; abrupt smooth boundary.

2Btx—26 to 33 inches; pale brown (10YR 6/3) very cherty silty clay loam; many fine faint light gray (10YR 7/2) mottles; weak medium platy structure parting to weak fine subangular blocky; brittle; many prominent clay films on faces of peds; 55 percent chert fragments; strongly acid; abrupt smooth boundary.

2Bt1—33 to 44 inches; strong brown (7.5YR 4/6) very cherty clay; many medium prominent red (10R 4/8) and dark reddish brown (2.5YR 3/4) mottles; weak fine subangular blocky structure; very firm; many prominent clay films on faces of peds; 55 percent chert fragments; medium acid; gradual smooth boundary.

2Bt2—44 to 60 inches; red (2.5YR 4/6) very cherty clay; weak fine subangular blocky structure; 55 percent chert fragments; very firm; medium acid.

The thickness of the solum and the depth to bedrock are more than 60 inches. Depth to the fragipan is 18 to 36 inches. The content of chert fragments ranges from 0 to 5 percent in the A horizon, from 0 to 10 percent in the Bt horizon, and from 20 to 60 percent in and below the 2Btx horizon.

The A horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. The Bt horizon has hue of 10YR to 5YR and value of 3 to 5. It is silty clay loam or silty clay. The 2Btx horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 3 to 6. The 2Bt horizon is the cherty, very cherty, or extremely cherty analog of clay or silty clay.

Deepwater Series

The Deepwater series consists of deep, moderately well drained, moderately permeable soils on uplands. These soils formed in a thin mantle of loess and in the underlying shale residuum. Slopes range from 2 to 9 percent.

Typical pedon of Deepwater silt loam, 2 to 5 percent slopes, 1,680 feet west and 1,800 feet north of the southeast corner of sec. 18, T. 43 N., R. 23 W.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; common fine roots; few fine concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

A—5 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; common fine roots; few fine worm casts; few fine concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

Bt1—11 to 20 inches; brown (10YR 4/3) silty clay loam; few fine prominent strong brown (7.5YR 5/8) mottles; weak fine subangular blocky structure; friable; few fine roots; few fine worm casts; few faint clay films on faces of peds; few fine concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt2—20 to 29 inches; yellowish brown (10YR 5/4) silty clay loam; common fine prominent yellowish red (5YR 4/6) and few fine distinct gray (10YR 5/1) mottles; weak fine subangular blocky structure; friable; few fine roots; few fine worm casts; few faint clay films on faces of peds; few fine concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bt3—29 to 48 inches; mottled light brownish gray (10YR 6/2), yellowish brown (10YR 5/8), and yellowish red (5YR 4/6) silty clay loam; weak coarse blocky structure; friable; few fine roots; few faint clay films

on faces of peds; few fine concretions of iron and manganese oxides; medium acid; clear smooth boundary.

C—48 to 60 inches; yellowish red (5YR 5/8) clay loam; common medium prominent light gray (10YR 7/1) mottles; massive; friable; 10 percent soft sandstone fragments; slightly acid.

The thickness of the solum ranges from 48 to 72 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is silt loam, silty clay loam, or loam. The Bt horizon has hue of 10YR or 7.5YR and chroma of 3 to 6. It is silty clay loam, clay loam, or silty clay. The content of sandstone or shale fragments is as much as 10 percent in the lower part of this horizon.

Doniphan Series

The Doniphan series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in cherty sediments and in the underlying material weathered from clay shale and dolomite or cherty limestone. Slopes range from 3 to 14 percent.

Typical pedon of Doniphan cherty silt loam, 3 to 9 percent slopes, 1,300 feet south and 1,500 feet west of the northeast corner of sec. 30, T. 39 N., R. 20 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) cherty silt loam, gray (10YR 5/1) dry; weak fine granular structure; very friable; many medium roots; 15 percent chert fragments; medium acid; abrupt smooth boundary.

E—3 to 8 inches; brown (10YR 4/3) cherty silt loam; weak fine granular structure; very friable; many medium roots; 15 percent chert fragments; strongly acid; abrupt wavy boundary.

Bt1—8 to 13 inches; yellowish red (5YR 4/6) cherty clay; weak fine subangular blocky structure; firm; many medium roots; 15 percent chert fragments; extremely acid; abrupt wavy boundary.

Bt2—13 to 18 inches; yellowish red (5YR 5/6) cherty clay; many medium prominent very pale brown (10YR 7/3) and many fine prominent dark red (2.5YR 3/6) mottles; weak fine subangular blocky structure; firm; many medium roots; 20 percent chert fragments; extremely acid; clear smooth boundary.

2Bt3—18 to 23 inches; red (10R 4/8) clay; moderate fine subangular blocky structure; very firm; many fine roots; many prominent dark red (2.5YR 3/6) clay films on faces of peds; many prominent pale brown (10YR 6/3) silt coatings on faces of peds; extremely acid; gradual smooth boundary.

2Bt4—23 to 37 inches; red (10R 4/8) clay; moderate fine subangular blocky structure; very firm; common fine roots; many prominent pale brown (10YR 6/3) silt coatings on faces of peds; extremely acid; gradual smooth boundary.

2Bt5—37 to 60 inches; dark red (10R 3/6) clay; few medium prominent light brownish gray (10YR 6/2) mottles; moderate fine subangular blocky structure; very firm; few fine roots; many prominent clay films on faces of peds; 5 percent chert fragments; extremely acid.

The thickness of the solum ranges from 60 to more than 100 inches. The content of chert fragments ranges from 25 to 75 percent in the A horizon and from 0 to 15 percent in the 2Bt horizon.

The A horizon has value of 2 to 4 and chroma of 1 to 3. It is the cherty or very cherty analog of loam or silt loam. The Bt horizon has hue of 10R to 7.5YR, value of 3 to 5, and chroma of 4 to 8. The content of clay in the upper 20 inches of the argillic horizon ranges from 48 to 70 percent.

Eldon Series

The Eldon series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in cherty material weathered from limestone interbedded with shale and sandstone. Slopes range from 3 to 14 percent.

Typical pedon of Eldon cherty silt loam, 3 to 9 percent slopes, 350 feet west and 200 feet south of the northeast corner of sec. 5, T. 43 N., R. 21 W.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) cherty silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; few coarse and many fine roots; few worm casts; 5 percent coarse chert fragments and 15 percent fine chert fragments; very strongly acid; clear smooth boundary.

A2—5 to 10 inches; very dark grayish brown (10YR 3/2) cherty silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine and common medium roots; few worm casts; 8 percent chert fragments larger than 3 inches and 15 percent chert fragments smaller than 3 inches; very strongly acid; clear wavy boundary.

Bt1—10 to 22 inches; reddish brown (5YR 4/4) very

cherty silty clay loam; weak fine subangular blocky structure; friable; many fine roots; few distinct clay films; 10 percent coarse chert fragments and 35 percent fine chert fragments; very strongly acid; clear wavy boundary.

Bt2—22 to 28 inches; red (2.5YR 4/6) very cherty silty clay; weak fine subangular blocky structure; firm; common fine roots; common prominent clay films; 40 percent chert fragments; very strongly acid; clear wavy boundary.

2Bt3—28 to 60 inches; red (2.5YR 4/8) clay; moderate coarse angular blocky structure parting to weak fine subangular blocky; very firm; common fine roots; few slickensides; many prominent clay films; very strongly acid.

The solum is more than 60 inches thick. The content of coarse fragments ranges from 8 to 40 percent in the A horizon and from 18 to 85 percent in the Bt horizon. The chert content in the upper 20 inches of the argillic horizon averages more than 35 percent.

The A horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. It is silt loam, loam, or the cherty analog of those textures. The Bt horizon has hue of 5YR, 2.5YR, or 10YR, value of 3 or 4, and chroma of 3 to 6. It is the very cherty analog of clay, silty clay, or silty clay loam. The 2Bt horizon is clay, cherty clay, silty clay, or cherty silty clay.

Gasconade Series

The Gasconade series consists of shallow, somewhat excessively drained soils on uplands. These soils formed in limestone residuum. Permeability is moderately slow. Slopes range from 2 to 50 percent.

Typical pedon of Gasconade flaggy silty clay loam, in an area of Gasconade-Rock outcrop complex, 2 to 9 percent slopes; about 1,380 feet east and 2,110 feet north of the southwest corner of sec. 27, T. 40 N., R. 23 W.

A—0 to 8 inches; black (10YR 2/1) flaggy silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; many fine and medium roots; 20 percent chert fragments and 10 percent limestone flagstones; neutral; abrupt wavy boundary.

Bw—8 to 15 inches; dark brown (7.5YR 3/2) very flaggy silty clay loam; massive; firm; many fine roots; 55 percent limestone fragments; neutral; abrupt irregular boundary.

R—15 inches; hard limestone bedrock.

The thickness of the solum ranges from about 4 to 20 inches and commonly is the same as the depth to limestone bedrock. The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 3 or 4, and chroma of 2 to 4. It is the very flaggy analog of silty clay loam, silty clay, clay, or clay loam.

Goss Series

The Goss series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in cherty limestone residuum. Slopes range from 14 to 45 percent.

Typical pedon of Goss cherty silt loam, 14 to 45 percent slopes, 2,010 feet east and 30 feet north of the southwest corner of sec. 17, T. 39 N., R. 20 W.

A—0 to 5 inches; dark brown (10YR 3/3) cherty silt loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; many fine roots; 15 percent chert fragments; medium acid; abrupt smooth boundary.

E—5 to 13 inches; yellowish brown (10YR 5/4) very cherty silt loam; weak fine granular structure; very friable; many fine roots; 30 percent chert fragments larger than 3 inches and 10 percent chert fragments smaller than 3 inches; very strongly acid; clear smooth boundary.

Bt1—13 to 22 inches; strong brown (7.5YR 5/6) extremely cherty silty clay loam; weak fine subangular blocky structure; friable; many fine and medium roots; few faint clay films on faces of peds; 40 percent chert fragments larger than 3 inches and 25 percent chert fragments smaller than 3 inches; very strongly acid; clear smooth boundary.

Bt2—22 to 31 inches; red (2.5YR 4/6) very cherty silty clay; moderate fine subangular blocky structure; firm; common medium and coarse roots; few faint clay films on faces of peds; 25 percent chert fragments larger than 3 inches and 10 percent chert fragments smaller than 3 inches; very strongly acid; clear smooth boundary.

Bt3—31 to 43 inches; red (2.5YR 4/6) very cherty clay; moderate fine subangular blocky structure; very firm; common medium and coarse roots; many prominent clay films on faces of peds; 25 percent chert fragments larger than 3 inches and 25 percent chert fragments smaller than 3 inches; very strongly acid; clear smooth boundary.

Bt4—43 to 60 inches; red (2.5YR 4/6) very cherty clay;

weak fine subangular blocky structure; very firm; few medium and coarse roots; many prominent clay films on faces of peds; 55 percent chert fragments (40 percent larger than 3 inches and 15 percent smaller than 3 inches); very strongly acid.

The thickness of the solum ranges from 55 inches to more than 8 feet. The content of coarse fragments ranges from 10 to 80 percent throughout the profile.

The A horizon has value of 3 or 4 and chroma of 2 to 4. It typically is cherty silt loam, but the range includes silt loam and very cherty silt loam. The E horizon has value of 5 or 6 and chroma of 3 or 4. The Bt horizon typically has hue of 10R to 7.5YR and chroma of 4 to 8. It has value of 4 or 5 in the upper part and value of 3 to 5 in the lower part. This horizon is the cherty to extremely cherty analogs of silty clay loam, silty clay, or clay.

Hartwell Series

The Hartwell series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in loess and in shale residuum. Slopes range from 0 to 3 percent.

Typical pedon of Hartwell silt loam, 0 to 2 percent slopes, 1,900 feet south and 100 feet west of the northeast corner of sec. 30, T. 43 N., R. 22 W.

Ap1—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; few fine roots; neutral; abrupt smooth boundary.

Ap2—7 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak fine granular; very friable; few fine roots; few fine concretions of iron and manganese oxides; strongly acid; abrupt smooth boundary.

E—10 to 13 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; very friable; few fine roots; few fine concretions of iron and manganese oxides; strongly acid; abrupt smooth boundary.

Bt1—13 to 23 inches; very dark grayish brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) dry; many medium prominent dark brown (7.5YR 3/4) mottles; weak fine subangular blocky structure; very firm; few very fine roots; many prominent clay films on faces of peds; few fine concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt2—23 to 28 inches; grayish brown (10YR 5/2) silty clay; many coarse faint light brownish gray (10YR 6/2) and few fine prominent dark brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; very firm; few fine roots; many prominent clay films on faces of peds; few fine concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Bt3—28 to 34 inches; grayish brown (2.5Y 5/2) silty clay loam; many fine prominent dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; few medium concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

C1—34 to 41 inches; olive gray (5Y 5/2) silty clay loam; many coarse prominent yellowish brown (10YR 5/6) mottles; massive; friable; few root pores; few fine concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

C2—41 to 60 inches; gray (10YR 6/1) silty clay loam; many coarse prominent yellowish brown (10YR 5/6) mottles; massive; friable; few root pores; few fine concretions of iron and manganese oxides; slightly acid.

The thickness of the solum ranges from 30 to 60 inches. The mollic epipedon typically is less than 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 to 6 and chroma of 1 or 2. The upper part of the Bt horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. The lower part has value of 5 to 7 and chroma of 2 to 8. This horizon is clay or silty clay in the upper part and silty clay loam or silty clay in the lower part.

Knobby Series

The Knobby series consists of very shallow, well drained, moderately permeable soils on dissected uplands. These soils formed in loamy dolomite residuum. Slopes range from 3 to 50 percent.

Typical pedon of Knobby gravelly loam, in an area of Knobby-Rock outcrop complex, 3 to 9 percent slopes; 2,500 feet west and 300 feet south of the northeast corner of sec. 19, T. 39 N., R. 20 W.

A1—0 to 3 inches; very dark gray (10YR 3/1) gravelly loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; 30 percent dolomite fragments; mildly alkaline; abrupt wavy boundary.

A2—3 to 7 inches; very dark gray (10YR 3/1) very

gravelly sandy loam; weak fine granular structure; very friable; many fine roots; 45 percent dolomite fragments; mildly alkaline; abrupt wavy boundary.
R—7 inches; hard, fractured dolomite bedrock.

The depth to bedrock ranges from 4 to 14 inches. The clay content ranges from 10 to 18 percent in the fine-earth fraction. The A horizon has value of 2 or 3 and chroma of 1 or 2.

Mandeville Series

The Mandeville series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in acid shale residuum. Slopes range from 2 to 5 percent.

Typical pedon of Mandeville silt loam, 2 to 5 percent slopes, 100 feet north and 1,900 feet east of the southwest corner of sec. 31, T. 43 N., R. 23 W.

A—0 to 8 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.
BA—8 to 13 inches; dark brown (7.5YR 4/4) silt loam; weak fine subangular blocky structure parting to weak fine granular; very friable; common very fine roots; few fine concretions of iron and manganese oxides; 10 percent shale fragments; strongly acid; clear smooth boundary.
Bt1—13 to 20 inches; strong brown (7.5YR 4/6) silty clay loam; weak fine subangular blocky structure; firm; few very fine roots; few distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; 10 percent shale fragments; very strongly acid; clear smooth boundary.
Bt2—20 to 26 inches; yellowish brown (10YR 5/4) silty clay loam; common fine prominent red (2.5YR 4/8) mottles; weak fine subangular blocky structure; firm; few very fine roots; common distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; 10 percent shale fragments; very strongly acid; clear smooth boundary.
BC—26 to 32 inches; yellowish brown (10YR 5/6) channery silty clay loam; many fine prominent red (2.5YR 4/8) and strong brown (7.5YR 5/8) mottles; moderate fine subangular blocky structure; firm; few fine roots; 20 percent shale and sandstone fragments; very strongly acid; gradual smooth boundary.
Cr—32 to 60 inches; multicolored, soft weathered shale; few fine roots; yellowish brown (10YR 5/6) soil material in cracks.

The thickness of the solum ranges from 20 to 40 inches. The depth to rippable soft shale bedrock ranges from 20 to 40 inches, and the depth to hard bedrock is greater than 60 inches.

The A horizon has value of 4 or 5 and chroma of 2 or 3. Some pedons have an E horizon. This horizon has value of 5 or 6 and chroma of 3 or 4. The Bt horizon has value of 4 to 6 and chroma of 2 to 6.

McGirk Series

The McGirk series consists of deep, poorly drained, slowly permeable soils on the lower side slopes and foot slopes in the uplands. These soils formed in local colluvium and alluvium. Slopes range from 2 to 5 percent.

Typical pedon of McGirk silt loam, 2 to 5 percent slopes, 2,640 feet east and 620 feet south of the northwest corner of sec. 16, T. 43 N., R. 20 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium platy structure parting to weak fine granular; very friable; few fine roots; few fine concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.
E—7 to 14 inches; light brownish gray (10YR 6/2) silt loam; weak fine granular structure; very friable; few fine roots; few fine concretions of iron and manganese oxides; strongly acid; abrupt smooth boundary.
BE—14 to 21 inches; grayish brown (10YR 5/2) silty clay loam; weak fine subangular blocky structure; friable; few fine roots; few fine concretions of iron and manganese oxides; strongly acid; clear smooth boundary.
Bt1—21 to 26 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium prominent dark yellowish brown (10YR 4/6) and many medium faint light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; firm; few fine roots; few distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; very strongly acid; clear smooth boundary.
Bt2—26 to 47 inches; mottled grayish brown (10YR 5/2), light gray (10YR 7/2), and strong brown (7.5YR 4/6) silty clay loam; moderate medium subangular blocky structure; firm; few very fine roots; many prominent and few distinct clay films on faces of peds; common fine concretions of iron and manganese oxides; very strongly acid; gradual smooth boundary.
Bt3—47 to 54 inches; grayish brown (2.5Y 5/2) silty

clay; common coarse prominent strong brown (7.5YR 4/6) mottles; weak medium blocky structure; firm; few slickensides; common fine concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Cg—54 to 60 inches; gray (5Y 6/1) silty clay loam; common medium prominent strong brown (7.5YR 4/6) mottles; massive; firm; common fine concretions of iron and manganese oxides; medium acid.

The thickness of the solum ranges from 40 to more than 60 inches. The Ap horizon has value of 4 or 5 and chroma of 2 or 3. The E horizon has value of 6 or 7. The Bt horizon has value of 4 to 6 and chroma of 1 or 2. It has mottles with chroma of 2 to 8. The clay content in this horizon ranges from 35 to 50 percent.

Moniteau Series

The Moniteau series consists of deep, poorly drained, moderately slowly permeable soils on stream terraces. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Moniteau silt loam, 1,750 feet west and 2,650 feet north of the southeast corner of sec. 6, T. 39 N., R. 23 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; weak fine granular structure; very friable; many fine roots; few fine concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

E—8 to 14 inches; light brownish gray (10YR 6/2) silt loam; many medium faint light gray (10YR 7/1), common fine distinct dark yellowish brown (10YR 4/4), and common fine distinct yellowish brown (10YR 5/4) mottles; weak fine granular structure; very friable; few fine roots; many root pores; few fine concretions of iron and manganese oxides; medium acid; clear smooth boundary.

BE—14 to 20 inches; grayish brown (10YR 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; few fine roots; few fine concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Btg1—20 to 35 inches; light brownish gray (10YR 6/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; very few fine roots; common distinct clay films on faces of peds; few medium concretions of iron and manganese oxides; strongly acid; gradual smooth boundary.

Btg2—35 to 49 inches; dark grayish brown (10YR 4/2) silty clay loam; many medium distinct dark yellowish brown (10YR 4/4) and many medium faint gray (10YR 6/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; very few fine roots; common distinct clay films in root channels and on faces of peds; few fine concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Cg—49 to 60 inches; gray (10YR 6/1) silty clay loam; many fine distinct dark yellowish brown (10YR 4/4) mottles; weak coarse prismatic structure parting to weak coarse blocky; friable; very few very fine roots; few root pores; common distinct clay films in root pores; few fine concretions of iron and manganese oxides; slightly acid.

The thickness of the solum ranges from 36 to 72 inches. The A or Ap horizon has value of 4 or 5 and chroma of 1 or 2. The E horizon has value of 4 to 7 and chroma of 1 or 2. The Btg and Cg horizons have hue of 10YR to 5Y. The C horizon is silty clay loam or silt loam.

Osage Series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in thick deposits of clayey alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Osage silty clay loam, 450 feet south and 750 feet east of the northwest corner of sec. 4, T. 38 N., R. 22 W.

Ap—0 to 5 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine roots; slightly acid; abrupt smooth boundary.

A1—5 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; common fine roots; slightly acid; abrupt smooth boundary.

A2—8 to 24 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; very firm; few fine roots; slightly acid; gradual smooth boundary.

Bg1—24 to 37 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine

subangular blocky structure; very firm; few fine roots; neutral; clear smooth boundary.

Bg2—37 to 50 inches; dark gray (10YR 4/1) silty clay; moderate medium subangular blocky structure; very firm; few fine roots; few fine concretions of iron and manganese oxides; black (10YR 2/1) stains in root channels; slightly effervescent; mildly alkaline; gradual smooth boundary.

Bg3—50 to 60 inches; dark gray (10YR 4/1) silty clay; few fine prominent brownish yellow (10YR 6/8) mottles; moderate fine subangular blocky structure; very firm; few fine concretions of iron and manganese oxides; black (10YR 2/1) stains in root channels; slightly effervescent; mildly alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. Some pedons have free calcium carbonates below a depth of about 36 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It is silty clay loam, silty clay, or clay. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 2 or less. The clay content in the 10- to 40-inch control section ranges from 35 to 60 percent.

Quarles Series

The Quarles series consists of deep, poorly drained, slowly permeable soils on low stream terraces. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Quarles silt loam, 300 feet south and 1,400 feet east of the northwest corner of sec. 19, T. 43 N., R. 22 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; weak medium platy structure parting to weak fine granular; very friable; many fine roots; few fine concretions of iron and manganese oxides; neutral; abrupt smooth boundary.

Eg—9 to 18 inches; gray (10YR 5/1) silt loam; common fine distinct dark brown (10YR 4/3) mottles; weak medium platy structure parting to weak fine granular; very friable; many fine roots; few fine concretions of iron and manganese oxides; very strongly acid; clear smooth boundary.

BEg—18 to 21 inches; gray (10YR 5/1) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; many fine and common medium roots; few fine concretions of iron and manganese oxides; very strongly acid; clear smooth boundary.

Btg1—21 to 31 inches; dark gray (10YR 4/1) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; common fine and medium roots; many prominent clay films on faces of peds; many prominent silt coatings on some peds; common fine concretions of iron and manganese oxides; very strongly acid; gradual smooth boundary.

Btg2—31 to 50 inches; mottled light gray (10YR 7/1), light brownish gray (10YR 6/2), and brown (10YR 5/3) silty clay loam; weak fine subangular blocky structure; friable; common fine roots; few prominent and common distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; very strongly acid; gradual smooth boundary.

Cg—50 to 60 inches; dark brown (10YR 4/3) silty clay loam; few medium faint light brownish gray (10YR 6/2) mottles; massive; friable; few fine roots; few fine concretions of iron and manganese oxides; very strongly acid.

The thickness of the solum ranges from 36 to more than 60 inches. The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 to 6 and chroma of 1 or 2. The upper part of the Btg horizon has hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 1 or less. The lower part has chroma of 1 to 6. This horizon is silty clay loam or silty clay.

Racket Series

The Racket series consists of deep, well drained, moderately permeable soils on flood plains along small streams. These soils formed in alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Racket silt loam, 1,520 feet north and 330 feet west of the southeast corner of sec. 19, T. 40 N., R. 20 W.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; neutral; clear wavy boundary.

A2—7 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; 10 percent pebbles; common fine worm casts; neutral; clear wavy boundary.

A3—10 to 21 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak

fine granular structure; very friable; many fine roots; common fine worm casts; neutral; gradual wavy boundary.

A4—21 to 42 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; common fine roots; few fine worm casts; neutral; abrupt smooth boundary.

C—42 to 60 inches; dark yellowish brown (10YR 4/4), stratified very gravelly loamy sand and extremely gravelly sand; single grain; loose; very friable; neutral.

The thickness of the mollic epipedon ranges from 24 to 42 inches. The A horizon has value of 2 or 3 and chroma of 1 to 3. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4.

Sampsel Series

The Sampsel series consists of deep, poorly drained, slowly permeable soils on foot slopes. These soils formed in colluvial sediments or shale residuum. Slopes range from 2 to 9 percent.

Typical pedon of Sampsel silty clay loam, 2 to 5 percent slopes, 2,000 feet north and 500 feet east of the southwest corner of sec. 5, T. 38 N., R. 21 W.

Ap—0 to 5 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many fine roots; few fine concretions of iron and manganese oxides; slightly acid; abrupt smooth boundary.

A—5 to 10 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; common fine roots; few fine chert fragments; few fine concretions of iron and manganese oxides; neutral; clear smooth boundary.

Bt1—10 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; few fine distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; firm; few fine roots; few faint clay films on faces of peds; common medium concretions of iron and manganese oxides; few fine chert fragments; neutral; clear smooth boundary.

Bt2—15 to 25 inches; dark grayish brown (10YR 4/2) silty clay; many fine distinct yellowish brown (10YR 5/8) and many fine faint dark gray (10YR 4/1) mottles; weak fine subangular blocky structure; very firm; few fine roots; common distinct clay films on faces of peds; common medium concretions of iron and manganese oxides; few fine chert fragments; neutral; gradual smooth boundary.

Bt3—25 to 36 inches; dark grayish brown (10YR 4/2) silty clay; many medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very firm; few very fine roots; many distinct clay films on faces of peds; common medium concretions of iron and manganese oxides; less than 5 percent chert fragments; slightly acid; gradual smooth boundary.

Bt4—36 to 41 inches; dark grayish brown (10YR 4/2) silty clay; many coarse distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very firm; few very fine roots; many prominent clay films on faces of peds; many medium concretions of iron and manganese oxides; few fine chert fragments; neutral; clear smooth boundary.

Bt5—41 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam; many coarse prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; common prominent clay films on faces of peds; many medium concretions of iron and manganese oxides; neutral.

The thickness of the solum ranges from 36 to more than 60 inches. The depth to bedrock is more than 6 feet.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It typically is silty clay loam, but the range includes silt loam. The Bt horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 or 2. It is silty clay loam, silty clay, or clay.

Union Series

The Union series consists of deep, moderately well drained soils on uplands. These soils have a fragipan. They formed in loess and in cherty limestone residuum. Permeability is moderate above the fragipan and slow in the fragipan. Slopes range from 2 to 9 percent.

Typical pedon of Union silt loam, 2 to 5 percent slopes, 1,020 feet south and 90 feet east of the northwest corner of sec. 14, T. 39 N., R. 21 W.

A—0 to 4 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

E—4 to 7 inches; yellowish brown (10YR 5/4) silt loam; weak fine granular structure; very friable; many fine roots; few fine concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bt1—7 to 10 inches; dark yellowish brown (10YR 4/6) silty clay loam; moderate fine subangular blocky structure; friable; many fine roots; few faint clay films on faces of peds; few fine concretions of iron and manganese oxides; very strongly acid; abrupt smooth boundary.

Bt2—10 to 16 inches; dark yellowish brown (10YR 4/6) silty clay loam; moderate fine subangular blocky structure; firm; few fine roots; common faint clay films on faces of peds; few fine concretions of iron and manganese oxides; very strongly acid; abrupt smooth boundary.

Bt3—16 to 22 inches; dark yellowish brown (10YR 4/6) silty clay loam; common fine distinct grayish brown (10YR 5/2) and few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; few fine roots; many distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; very strongly acid; abrupt smooth boundary.

Bt4—22 to 27 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/6) and few fine prominent brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; very strongly acid; abrupt boundary.

2Btx1—27 to 30 inches; grayish brown (10YR 5/2) very cherty silty clay loam; few fine prominent brown (7.5YR 4/4) mottles; massive; brittle; 45 percent chert fragments; very strongly acid; clear wavy boundary.

2Btx2—30 to 42 inches; pale brown (10YR 6/3) very cherty silty clay loam; many fine prominent strong brown (7.5YR 4/6) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; brittle; common prominent clay films on faces of peds; 40 percent chert fragments; very strongly acid; abrupt smooth boundary.

2Bt1—42 to 54 inches; red (2.5YR 4/6) very cherty clay; many medium prominent pale brown (10YR 6/3) mottles; moderate medium subangular blocky structure; very firm; 40 percent chert fragments; very strongly acid; abrupt wavy boundary.

2Bt2—54 to 60 inches; strong brown (7.5YR 4/6) cherty clay; many coarse prominent very pale brown (10YR 7/3) mottles; weak fine angular blocky structure; very firm; 25 percent chert fragments; strongly acid.

The thickness of the solum ranges from 40 to more than 60 inches. Depth to the fragipan is 26 to 36 inches, and the depth to bedrock is more than 60 inches.

The A horizon has value of 3 or 4 and chroma of 2 or 3. The Bt horizon has hue of 10YR to 5YR and chroma of 2 to 6. The clay content in this horizon ranges from 35 to 40 percent. The 2Btx horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 6. It is silt loam, silty clay loam, or the cherty or very cherty analog of those textures. The 2Bt horizon has chroma of 4 to 6. It is silty clay loam, silty clay, clay, or the cherty or very cherty analog of those textures. The content of chert fragments in this horizon ranges from 0 to 60 percent.

Verdigris Series

The Verdigris series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Verdigris silt loam, 600 feet north and 800 feet east of the southwest corner of sec. 31, T. 43 N., R. 23 W.

Ap—0 to 6 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak thin platy structure parting to weak fine granular; very friable; many fine roots; medium acid; abrupt smooth boundary.

A1—6 to 10 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak medium platy structure parting to weak fine granular; very friable; many fine roots; medium acid; clear smooth boundary.

A2—10 to 16 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak fine granular; very friable; many fine roots; few worm casts; slightly acid; gradual smooth boundary.

A3—16 to 27 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many fine roots; few worm casts; slightly acid; gradual smooth boundary.

AC—27 to 44 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; friable; common fine roots; slightly acid; clear smooth boundary.

C—44 to 60 inches; brown (10YR 5/3) silt loam; many medium distinct gray (10YR 6/1) and many medium

faint yellowish brown (10YR 5/4) mottles; massive; friable; common fine roots; slightly acid.

The thickness of the solum ranges from 24 to 60 inches. The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 to 3. It is silt loam, loam, or silty clay loam. The AC horizon is silt loam or silty clay loam. It has hue, value, and chroma similar to those of the A1 horizon. The C horizon has hue of 7.5YR or 10YR, value of 3 to 6, and chroma of 2 to 4. It is silt loam or silty clay loam.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the type of parent material; plant and animal life on and in the soil; the climate under which the soil material accumulated; the relief, or lay of the land; and the length of time that the forces of soil formation have been active.

Parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Plant and animal life, chiefly plants, are active factors of soil formation. Climate determines the amount of water for leaching and the amount of heat available for physical and chemical changes. Together, climate and plant and animal life act on the parent material that has accumulated and slowly change it to a natural body that has genetically related horizons. Relief modifies the effects of climate and plant and animal life. Finally, time is needed for the transformation of the parent material into a soil. Generally, a long time is required for the development of distinct soil horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. The accumulation or deposition of this material is the first step in the development of a soil profile. The characteristics of the material affect the chemical and mineralogical composition of the soil. The kinds of parent material in Benton County are residual material weathered from bedrock; colluvium, or material deposited at the base of slopes; loess, or wind-deposited material; and alluvium, or water-deposited material.

Benton County has three types of residual material. Barco and Bolivar soils formed in sandstone residuum. Mandeville soils formed in shale residuum. Bardley, Doniphan, Eldon, Gasconade, Goss, and Knobby soils formed in cherty limestone and dolomite residuum.

Colluvium is unconsolidated earth material moved by creep, slide, or local wash and deposited at the base of slopes. McGirk and Claiborne are examples of soils that formed in colluvium.

Loess, which is made up principally of silt, was transported into Benton County mainly from the flood plains along the Missouri River. Because of the distance from the source, the soils in Benton County have a thin layer of loess that overlies residuum. Barden, Deepwater, and Hartwell soils formed in loess and in the underlying shale residuum, and Creldon and Union soils formed in loess and in the underlying cherty limestone or dolomite residuum.

Alluvium is material that was transported by water and deposited on nearly level flood plains. This material varies greatly in texture and mineralogical composition, reflecting the diverse origin and varying speed of the flowing water. Racket and Verdigris soils, which border the streams, are examples of soils that formed in alluvium. They are coarser textured than Osage soils, which formed in material deposited in slack-water areas.

Plant and Animal Life

Plants, burrowing animals, insects, bacteria, and fungi have important effects on soil formation. Among the soil properties affected are the content of organic matter and plant nutrients, structure, and porosity.

Many of the soils in Benton County formed when the vegetation was mainly tall prairie grasses. These soils, generally known as "prairie soils," have a thick, dark surface layer that is high in content of organic matter as a result of abundant bacteria and decay of the fine grass roots. Deepwater, Gasconade, Hartwell, Osage, and Sampsel soils formed under this plant cover.

Soils that formed under deciduous forests have a light colored surface layer and a low organic matter content. Examples are Bardley, Bolivar, Claiborne, Doniphan, Goss, Mandeville, McGirk, Moniteau, and Union soils.

On a large acreage in Benton County, the soils either

formed first under prairie vegetation and then under forest vegetation or formed under mixed prairie and forest vegetation. Examples are Barco, Barden, Creldon, Eldon, and Quarles soils. Such soils have a surface layer that is lighter than that of the prairie soils and somewhat darker than that of the forest soils.

Relief

Relief affects soil formation through its influence on drainage, runoff, infiltration, and other factors, including accelerated erosion. Runoff generally is rapid on the steeper slopes and is slower in nearly level areas. In areas where most of the water runs off the surface, little water enters the soil. As a result, the soil forms slowly. In these areas soil horizons are indistinct and the solum is thin. Gasconade soils are a good example. In areas where little water runs off the surface, or where it runs off slowly, soil formation is rapid. In these areas soil horizons are distinct and the solum is thicker. Hartwell soils are an example.

Climate

Climate has been an important factor in the formation of soils in Benton County. It largely determines the rate of weathering in soils, and it also influences the type of vegetation that grows on the soils. Benton County has a temperate, humid continental climate. The average precipitation is about 41 inches, and the frost-free season averages 180 days. The prevailing winds are from the south or southeast. These winds are generally warm and moist. Between mid-July and September of most years, however, the winds are hot and dry and rainfall is limited. Short periods of excessive rainfall are common in spring, fall, or both. The soils are frozen for short periods in winter. Soil-forming processes are slowed during these periods.

The humid climate of Benton County has favored the relatively rapid breakdown of minerals, the formation of clay, and the translocation of clay downward in the soil profile. The subsoil of Barden and Hartwell soils is high in clay content and is slowly permeable. As a result of the restricted permeability, these soils are excessively wet during periods of heavy rainfall.

Time

The degree of profile development reflects the length of time that the parent material has been in place and subject to weathering. Young soils show little evidence of profile development, or horizon differentiation. Mature soils, which show the effects of clay movement and leaching, have distinct horizons.

Verdigris and Racket are among the youngest soils in the county. The material in which these soils formed washed from nearby uplands and was deposited by the local streams. In areas of extreme erosion and deposition, several inches of this material probably was deposited in as little as 1 year. Horizons within the Verdigris and Racket soils are not distinct. The upper part of these soils is only slightly different from the rest of the profile. The differences are most likely a result of tillage and the incorporation of crop residue into the upper part of the profile in recent years.

Barden and Hartwell are examples of mature soils. They have a well developed subsoil that is high in clay content and that differs strikingly from the layers directly above and below. Hartwell soils formed in areas of subnormal relief. Runoff was slow, and the soils remained wet during most of the year. The degree of erosion under the native grasses was negligible. Water that did not evaporate or run off the surface moved downward through the soils. The subnormal relief and excess water hastened soil formation, and in time the clay particles moved from the surface layer down into the lower layers. This translocation of clay resulted in the accumulation of clay directly below a severely leached, silty subsurface layer. Relief had a very significant effect on the formation of these mature soils. It considerably shortened the length of time required for soil formation.

Barco, Deepwater, and Mandeville soils have been in place as long as Hartwell soils, but they show less evidence of horizon development. A much longer time is required for the development of distinct horizons in these soils. Differences in parent material, animal life, and relief have apparently been the dominant factors affecting the formation of these soils.

Some soils in the county are fairly youthful or very old. Doniphan soils are an example of the older soils. They formed on stable ridgetops and the upper side slopes where relief had little effect on soil formation. A fairly youthful profile is represented by the Mandeville soils, which have a relatively thin, moderately fine textured subsoil.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil.

The soil is not a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil

before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand,

loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-81 at Warsaw, Missouri)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January	42.5	18.9	30.7	71	-10	11	1.56	0.64	2.32	4	5.5
February	48.5	23.9	36.2	75	-5	20	1.87	.91	2.69	5	4.0
March	58.2	32.2	45.2	84	4	87	3.14	1.67	4.43	7	3.4
April	71.2	43.8	57.5	90	22	241	3.84	2.02	5.42	7	.4
May	78.1	52.8	65.5	91	32	481	4.79	2.90	6.47	8	.0
June	85.8	62.0	73.9	99	45	717	4.97	2.05	7.44	7	.0
July	91.3	66.6	79.0	104	51	899	3.98	1.27	6.19	6	.0
August	89.9	64.6	77.3	104	49	846	3.71	1.69	5.43	6	.0
September	82.4	56.8	69.6	98	37	588	4.55	1.93	6.77	6	.0
October	72.3	44.8	58.6	92	24	283	3.72	1.32	5.69	6	.0
November	57.9	33.5	45.7	80	10	47	2.46	.77	3.83	4	1.3
December	46.9	24.6	35.8	71	-4	8	1.94	1.02	2.74	5	3.4
Yearly:											
Average	68.8	43.7	56.3	---	---	---	---	---	---	---	---
Extreme	---	---	---	106	-13	---	---	---	---	---	---
Total	---	---	---	---	---	4,228	40.53	32.39	48.39	71	18.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-81 at Warsaw, Missouri)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 12	Apr. 22	May 5
2 years in 10 later than--	Apr. 7	Apr. 18	Apr. 30
5 years in 10 later than--	Mar. 30	Apr. 9	Apr. 21
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 21	Oct. 15	Oct. 4
2 years in 10 earlier than--	Oct. 26	Oct. 19	Oct. 9
5 years in 10 earlier than--	Nov. 4	Oct. 28	Oct. 17

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-81 at Warsaw, Missouri)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	199	181	160
8 years in 10	206	188	166
5 years in 10	218	201	178
2 years in 10	231	214	190
1 year in 10	238	221	196

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
8	Pits and Dumps	180	*
9	Udorthents, clayey	530	0.1
13B	Sampsel silty clay loam, 2 to 5 percent slopes	9,400	2.0
13C	Sampsel silty clay loam, 5 to 9 percent slopes	2,200	0.5
15	Ashton silt loam	4,000	0.8
20B	Creldon silt loam, 2 to 5 percent slopes	5,300	1.1
20C	Creldon silt loam, 5 to 9 percent slopes	4,750	1.0
23F	Goss cherty silt loam, 14 to 45 percent slopes	65,000	13.5
30	Verdigris silt loam	5,400	1.1
32	Racket silt loam	13,500	2.8
33	Quarles silt loam	3,300	0.7
35	Aquents, nearly level	1,800	0.4
50B	McGirk silt loam, 2 to 5 percent slopes	16,100	3.3
51C	Claiborne silt loam, 5 to 9 percent slopes	14,800	3.1
52B	Deepwater silt loam, 2 to 5 percent slopes	3,900	0.8
52C	Deepwater silt loam, 5 to 9 percent slopes	2,350	0.5
53B	Mandeville silt loam, 2 to 5 percent slopes	620	0.1
54	Moniteau silt loam	2,800	0.6
55B	Barco loam, 2 to 5 percent slopes	2,300	0.5
55C	Barco loam, 5 to 9 percent slopes	1,550	0.3
56C	Bolivar fine sandy loam, 5 to 9 percent slopes	1,350	0.3
56D	Bolivar fine sandy loam, 9 to 14 percent slopes	880	0.2
58	Hartwell silt loam, 0 to 2 percent slopes	16,200	3.4
58B2	Hartwell silt loam, 1 to 3 percent slopes, eroded	7,500	1.6
58B3	Hartwell silty clay loam, 1 to 3 percent slopes, severely eroded	1,200	0.2
60B	Barden silt loam, 1 to 5 percent slopes	17,400	3.6
60B2	Barden silt loam, 1 to 5 percent slopes, eroded	11,900	2.5
63B	Union silt loam, 2 to 5 percent slopes	13,400	2.8
63C	Union silt loam, 5 to 9 percent slopes	6,100	1.3
66C	Doniphan cherty silt loam, 3 to 9 percent slopes	30,000	6.2
66D	Doniphan cherty silt loam, 9 to 14 percent slopes	14,600	3.0
67C	Bardley cherty silt loam, 3 to 9 percent slopes	28,500	5.9
67E	Bardley very cherty silt loam, 9 to 35 percent slopes	73,300	15.2
68C	Eldon cherty silt loam, 3 to 9 percent slopes	19,400	4.0
68D	Eldon cherty silt loam, 9 to 14 percent slopes	8,500	1.8
72C	Gasconade-Rock outcrop complex, 2 to 9 percent slopes	6,400	1.3
72F	Gasconade-Rock outcrop complex, 9 to 50 percent slopes	24,200	5.0
74C	Knobby-Rock outcrop complex, 3 to 9 percent slopes	1,000	0.2
74F	Knobby-Rock outcrop complex, 9 to 50 percent slopes	2,250	0.5
80	Osage silty clay loam	550	0.1
	Water	36,972	7.7
	Total	481,382	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
13B	Sampsel silty clay loam, 2 to 5 percent slopes (where drained)
15	Ashton silt loam
20B	Creldon silt loam, 2 to 5 percent slopes
30	Verdigris silt loam
32	Racket silt loam
33	Quarles silt loam (where drained)
50B	McGirk silt loam, 2 to 5 percent slopes (where drained)
52B	Deepwater silt loam, 2 to 5 percent slopes
53B	Mandeville silt loam, 2 to 5 percent slopes
54	Moniteau silt loam (where drained)
55B	Barco loam, 2 to 5 percent slopes
58	Hartwell silt loam, 0 to 2 percent slopes (where drained)
58B2	Hartwell silt loam, 1 to 3 percent slopes, eroded (where drained)
60B	Barden silt loam, 1 to 5 percent slopes
60B2	Barden silt loam, 1 to 5 percent slopes, eroded
63B	Union silt loam, 2 to 5 percent slopes
80	Osage silty clay loam (where drained)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Tall fescue-red clover hay	Tall fescue
		Bu	Bu	Bu	Bu	Tons	AUM*
8**. Pits and Dumps							
9. Udorthents							
13B---------- Sampsel	IIe	86	31	74	35	3.6	7.7
13C---------- Sampsel	IIIe	80	29	66	31	---	7.1
15---------- Ashton	IIw	97	36	85	39	4.2	8.6
20B---------- Creldon	IIe	68	26	60	29	3.0	6.5
20C---------- Creldon	IIIe	65	23	55	26	2.8	5.8
23F---------- Goss	VIIe	---	---	---	---	---	3.2
30---------- Verdigris	IIw	100	36	85	40	4.4	9.0
32---------- Racket	IIw	97	36	85	39	4.2	8.6
33---------- Quarles	IIw	77	28	68	30	3.3	6.8
35. Aquents							
50B---------- McGirk	IIe	73	26	65	29	3.4	6.5
51C---------- Claiborne	IIIe	76	28	68	30	3.3	6.7
52B---------- Deepwater	IIe	113	41	98	46	5.0	10.0
52C---------- Deepwater	IIIe	106	39	92	43	4.6	9.5
53B---------- Mandeville	IIe	77	28	68	30	3.8	7.7
54---------- Moniteau	IIIw	72	34	80	37	4.1	8.3
55B---------- Barco	IIe	83	31	68	36	3.7	7.2

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Tall fescue-red clover hay	Tall fescue
		Bu	Bu	Bu	Bu	Tons	AUM*
55C---------- Barco	IIIe	76	28	68	30	3.3	6.7
56C---------- Bolivar	IIIe	60	21	50	24	2.5	5.4
56D---------- Bolivar	IVe	---	---	---	---	2.2	3.9
58---------- Hartwell	IIe	92	34	80	37	4.1	8.2
58B2---------- Hartwell	IIe	86	30	75	34	3.8	7.7
58B3---------- Hartwell	IIIe	83	31	73	35	3.7	7.2
60B---------- Barden	IIe	92	34	80	37	4.1	8.3
60B2---------- Barden	IIIe	86	31	75	35	3.8	7.7
63B---------- Union	IIe	68	26	60	29	3.6	6.0
63C---------- Union	IIIe	60	21	50	24	2.5	5.4
66C---------- Doniphan	IIIs	---	21	48	23	2.5	5.0
66D---------- Doniphan	IVs	---	---	---	---	2.1	3.8
67C---------- Bardley	IVe	50	15	40	20	2.3	4.5
67E---------- Bardley	VIIe	---	---	---	---	1.8	3.2
68C---------- Eldon	IVs	56	21	48	23	2.5	5.0
68D---------- Eldon	VIs	---	---	---	---	2.1	3.8
72C**---------- Gasconade-Rock outcrop	VIs	---	---	---	---	---	---
72F**---------- Gasconade-Rock outcrop	VIIs	---	---	---	---	---	---
74C**---------- Knobby-Rock outcrop	VIs	---	---	---	---	---	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Tall fescue-red clover hay	Tall fescue
		Bu	Bu	Bu	Bu	Tons	AUM*
74F**---------- Knobby-Rock outcrop	VIIs	---	---	---	---	---	---
80---------- Osage	IIIw	77	28	69	32	3.4	6.8

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
15--- Ashton	4A	Slight	Slight	Slight	Slight	Pin oak	75	57	Black walnut, eastern cottonwood, green ash.
						Hackberry	---	---	
						Hickory	---	---	
						Red maple	---	---	
						Green ash	---	---	
						American sycamore	---	---	
						American elm	---	---	
						Eastern cottonwood	---	---	
						White oak	---	---	
						Persimmon	---	---	
23F--- Goss	3R	Moderate	Moderate	Moderate	Slight	White oak	60	43	White ash, northern red oak.
						Post oak	---	---	
						Blackjack oak	---	---	
						Black oak	---	---	
30--- Verdigris	4A	Slight	Slight	Slight	Slight	Pin oak	75	57	Eastern cottonwood, American sycamore, pin oak, black walnut, green ash.
						Eastern cottonwood	87	95	
						Shagbark hickory	---	---	
						Hackberry	---	---	
						Black walnut	---	---	
						Silver maple	---	---	
						Green ash	---	---	
						White oak	56	39	
32--- Racket	5A	Slight	Slight	Slight	Slight	Black walnut	72	54	Black walnut.
						Northern red oak	---	---	
						American sycamore	---	---	
						Black cherry	---	---	
						White ash	---	---	
33--- Quarles	4W	Slight	Severe	Moderate	Moderate	Pin oak	80	62	Pecan, pin oak.
						Pecan	---	---	
						Eastern cottonwood	---	---	
50B--- McGirk	3W	Slight	Severe	Moderate	Moderate	White oak	55	38	White oak, pin oak, green ash, pecan, eastern cottonwood.
51C--- Claiborne	4A	Slight	Slight	Slight	Slight	White oak	70	52	Black walnut, shortleaf pine, northern red oak.
						Northern red oak	70	52	
						Black oak	70	52	
53B--- Mandeville	3D	Slight	Slight	Slight	Moderate	White oak	60	43	White oak, white ash.
						Black walnut	---	---	
						Black oak	---	---	
						Shagbark hickory	---	---	
						White ash	---	---	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
54--------- Moniteau	4W	Slight	Severe	Moderate	Moderate	Pin oak----------	70	52	White oak, pin oak, green ash, eastern cottonwood, silver maple, northern red oak.
56C, 56D-------- Bolivar	3D	Slight	Slight	Slight	Moderate	White oak----------	57	40	White oak, white ash, shortleaf pine, northern red oak.
						Black oak----------	---	---	
						Northern red oak----	---	---	
						Black walnut--------	---	---	
63B, 63C-------- Union	3D	Slight	Slight	Slight	Moderate	White oak----------	55	38	White oak, northern red oak, white ash.
						Post oak----------	---	---	
						Northern red oak----	---	---	
						Black oak----------	---	---	
66C, 66D-------- Doniphan	3F	Slight	Moderate	Slight	Slight	Black oak----------	63	46	White oak, northern red oak, black oak.
						White oak----------	59	42	
						Post oak----------	---	---	
						Northern red oak----	61	44	
67C--------- Bardley	2D	Slight	Slight	Slight	Moderate	Post oak----------	45	30	Shortleaf pine, eastern redcedar.
67E--------- Bardley	2R	Moderate	Moderate	Slight	Moderate	Post oak----------	45	30	Shortleaf pine, eastern redcedar.
72C**:									
Gasconade------	2D	Slight	Moderate	Moderate	Severe	Chinkapin oak-------	40	26	Eastern redcedar.
						Eastern redcedar----	---	---	
						White ash----------	---	---	
						Sugar maple---------	---	---	
						Mockernut hickory---	---	---	
						Post oak----------	---	---	
						Blackjack oak-------	---	---	
Rock outcrop.									
72F**:									
Gasconade------	2R	Slight	Severe	Moderate	Severe	Chinkapin oak-------	40	26	Eastern redcedar.
						Eastern redcedar----	---	---	
						White ash----------	---	---	
						Sugar maple---------	---	---	
						Mockernut hickory---	---	---	
						Post oak----------	---	---	
						Blackjack oak-------	---	---	
Rock outcrop.									
74C**, 74F**:									
Knobby---------	2F	Moderate	Severe	Severe	Severe	Eastern redcedar----	---	---	Eastern redcedar.

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
74C**, 74F**: Rock outcrop.									
80---------- Osage	4W	Slight	Moderate	Moderate	Moderate	Pin oak----------	75	57	Pin oak, pecan, eastern cottonwood.
						Pecan----------	---	---	
						Eastern cottonwood--	80	78	
						Bur oak----------	---	---	

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
8*: Pits. Dumps. 9. Udorthents					
13B, 13C---------- Sampsel	Lilac----------	Amur maple, Manchurian crabapple, Amur honeysuckle, autumn olive.	Eastern redcedar, green ash, hackberry, Austrian pine, jack pine, Russian olive.	Honeylocust-------	---
15---------- Ashton	---	Amur honeysuckle, lilac, Amur maple, autumn olive.	Eastern redcedar, hackberry, Russian olive.	Green ash, honeylocust, Norway spruce, eastern white pine, pin oak.	---
20B, 20C---------- Creldon	Lilac----------	Amur honeysuckle, Amur maple, autumn olive, Manchurian crabapple.	Russian olive, Austrian pine, eastern redcedar, jack pine, hackberry, green ash.	Honeylocust-------	---
23F---------- Goss	Amur honeysuckle, lilac, fragrant sumac.	Autumn olive------	Eastern redcedar, Austrian pine, honeylocust, hackberry, green ash, bur oak, Russian olive.	Siberian elm------	---
30---------- Verdigris	---	Lilac, Amur honeysuckle, Amur maple, autumn olive.	Eastern redcedar	Austrian pine, green ash, hackberry, pin oak, honeylocust, eastern white pine.	Eastern cottonwood.
32---------- Racket	---	Amur honeysuckle, lilac, Amur maple, autumn olive.	Eastern redcedar	Eastern white pine, green ash, Austrian pine, hackberry, honeylocust, pin oak.	Eastern cottonwood.
33---------- Quarles	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Norway spruce, honeylocust, green ash, silver maple, golden willow, northern red oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
35. Aquents					
50B---------- McGirk	Lilac----------	Amur honeysuckle, Amur maple, autumn olive, Manchurian crabapple.	Russian olive, Austrian pine, eastern redcedar, jack pine, hackberry, green ash.	Honeylocust-------	---
51C---------- Claiborne	---	Amur honeysuckle, lilac, Amur maple, autumn olive.	Eastern redcedar, Russian olive, hackberry.	Norway spruce, green ash, honeylocust, pin oak, eastern white pine.	---
52B, 52C---------- Deepwater	---	Amur honeysuckle, autumn olive, Amur maple, lilac.	Hackberry, Russian olive, eastern redcedar.	Norway spruce, pin oak, honeylocust, green ash, eastern white pine.	---
53B---------- Mandeville	Amur honeysuckle, fragrant sumac, lilac.	Autumn olive------	Russian olive, Austrian pine, eastern redcedar, bur oak, hackberry, green ash.	Honeylocust, Siberian elm.	---
54---------- Moniteau	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Norway spruce, green ash, golden willow, honeylocust, northern red oak, silver maple.	Eastern cottonwood.
55B, 55C---------- Barco	Amur honeysuckle, lilac, fragrant sumac.	Autumn olive------	Green ash, eastern redcedar, bur oak, Russian olive, Austrian pine, hackberry.	Siberian elm, honeylocust.	---
56C, 56D---------- Bolivar	Amur honeysuckle, lilac, fragrant sumac.	Autumn olive------	Green ash, hackberry, bur oak, Russian olive, Austrian pine, eastern redcedar.	Siberian elm, honeylocust.	---
58, 58B2, 58B3---- Hartwell	Lilac----------	Amur maple, Amur honeysuckle, autumn olive, Manchurian crabapple.	Eastern redcedar, hackberry, jack pine, Austrian pine, green ash, Russian olive.	Honeylocust-------	---
60B, 60B2--------- Barden	Lilac----------	Amur honeysuckle, autumn olive, Manchurian crabapple, Amur maple.	Eastern redcedar, Austrian pine, Russian olive, green ash, hackberry, jack pine.	Honeylocust-------	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
63B, 63C---------- Union	Lilac----------	Manchurian crabapple, Amur honeysuckle, Amur maple, autumn olive.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian olive.	Honeylocust-------	---
66C, 66D---------- Doniphan	Amur honeysuckle, lilac, fragrant sumac.	Autumn olive------	Austrian pine, honeylocust, eastern redcedar, hackberry, green ash, bur oak, Russian olive.	Siberian elm------	---
67C, 67E---------- Bardley	Lilac, fragrant sumac, Amur honeysuckle.	Autumn olive------	Russian olive, hackberry, eastern redcedar, bur oak, green ash, Austrian pine, honeylocust.	Siberian elm------	---
68C, 68D---------- Eldon	Amur honeysuckle, lilac, fragrant sumac.	Autumn olive------	Green ash, hackberry, honeylocust, bur oak, Russian olive, Austrian pine, eastern redcedar.	Siberian elm------	---
72C*, 72F*: Gasconade.					
Rock outcrop.					
74C*, 74F*: Knobby.					
Rock outcrop.					
80---------- Osage	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Norway spruce, honeylocust, green ash, silver maple, golden willow, northern red oak.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
8*: Pits. Dumps.					
9. Udorthents					
13B---- Sampsel	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, erodes easily.	Severe: wetness.
13C---- Sampsel	Severe: wetness.	Severe: wetness.	Severe: slope, wetness.	Severe: wetness, erodes easily.	Severe: wetness.
15---- Ashton	Severe: flooding.	Slight----	Moderate: flooding.	Slight----	Moderate: flooding.
20B---- Creldon	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Moderate: wetness.	Moderate: wetness.
20C---- Creldon	Severe: percs slowly.	Severe: percs slowly.	Severe: slope, percs slowly.	Moderate: wetness.	Moderate: wetness.
23F---- Goss	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: droughty.
30---- Verdigris	Severe: flooding.	Slight----	Moderate: flooding.	Slight----	Moderate: flooding.
32---- Racket	Severe: flooding.	Slight----	Moderate: small stones, flooding.	Slight----	Moderate: flooding.
33---- Quarles	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
35. Aquents					
50B---- McGirk	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
51C---- Claiborne	Slight----	Slight----	Severe: slope.	Slight----	Moderate: small stones.
52B---- Deepwater	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
52C---- Deepwater	Slight----	Slight----	Severe: slope.	Slight----	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
53B---------- Mandeville	Slight----------	Slight----------	Moderate: slope, thin layer, area reclaim.	Slight----------	Moderate: thin layer, area reclaim.
54---------- Moniteau	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
55B---------- Barco	Slight----------	Slight----------	Moderate: slope, thin layer, area reclaim.	Slight----------	Moderate: thin layer, area reclaim.
55C---------- Barco	Slight----------	Slight----------	Severe: slope.	Slight----------	Moderate: thin layer, area reclaim.
56C---------- Bolivar	Slight----------	Slight----------	Severe: slope.	Slight----------	Moderate: thin layer, area reclaim.
56D---------- Bolivar	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope, thin layer, area reclaim.
58, 58B2, 58B3-------- Hartwell	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
60B, 60B2---------- Barden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight----------	Slight.
63B---------- Union	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.	Moderate: wetness.
63C---------- Union	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: wetness.
66C, 66D---------- Doniphan	Severe: small stones.	Severe: small stones.	Severe: slope, small stones.	Moderate: large stones.	Severe: small stones.
67C---------- Bardley	Moderate: small stones.	Moderate: small stones.	Severe: slope, small stones.	Slight----------	Moderate: small stones.
67E---------- Bardley	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: small stones.	Severe: small stones, slope.
68C---------- Eldon	Moderate: small stones.	Moderate: small stones.	Severe: slope, small stones.	Slight----------	Moderate: small stones, large stones.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
68D---------- Eldon	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight----------	Moderate: small stones, large stones, slope.
72C*: Gasconade----------	Severe: thin layer.	Severe: thin layer.	Severe: large stones, thin layer.	Moderate: large stones.	Severe: large stones, thin layer.
Rock outcrop.					
72F*: Gasconade----------	Severe: slope, thin layer.	Severe: slope, thin layer.	Severe: large stones, slope, thin layer.	Severe: slope.	Severe: large stones, slope, thin layer.
Rock outcrop.					
74C*: Knobby----------	Severe: thin layer, area reclaim.	Severe: thin layer, area reclaim.	Severe: slope, small stones, thin layer.	Slight----------	Severe: droughty, thin layer.
Rock outcrop.					
74F*: Knobby----------	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, small stones, thin layer.	Severe: slope.	Severe: droughty, slope, thin layer.
Rock outcrop.					
80---------- Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
8*: Pits.										
Dumps.										
9. Udorthents										
13B, 13C---------- Sampsel	Fair	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
15---------- Ashton	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
20B, 20C---------- Creldon	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
23F---------- Goss	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
30---------- Verdigris	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
32---------- Racket	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
33---------- Quarles	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
35. Aquents										
50B---------- McGirk	Fair	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Very poor.
51C---------- Claiborne	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
52B---------- Deepwater	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
52C---------- Deepwater	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
53B---------- Mandeville	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
54---------- Moniteau	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
55B, 55C---------- Barco	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
56C, 56D---------- Bolivar	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
58---------- Hartwell	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
58B2, 58B3--------- Hartwell	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
60B, 60B2---------- Barden	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
63B---------- Union	Fair	Good	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
63C---------- Union	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
66C, 66D---------- Doniphan	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
67C---------- Bardley	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
67E---------- Bardley	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
68C, 68D---------- Eldon	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
72C*, 72F*: Gasconade--------- Rock outcrop.	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
74C*, 74F*: Knobby---------- Rock outcrop.	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
80---------- Osage	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
8*: Pits. Dumps. 9. Udorthents						
13B, 13C---------- Sampsel	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
15---------- Ashton	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength.	Moderate: flooding.
20B---------- Creldon	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength.	Moderate: wetness.
20C---------- Creldon	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength.	Moderate: wetness.
23F---------- Goss	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty.
30---------- Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
32---------- Racket	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
33---------- Quarles	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
35. Aquents						
50B---------- McGirk	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
51C---------- Claiborne	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Moderate: small stones.
52B---------- Deepwater	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
52C---------- Deepwater	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
53B---------- Mandeville	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: low strength, frost action.	Moderate: thin layer, area reclaim.
54---------- Moniteau	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
55B---------- Barco	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell, frost action.	Moderate: thin layer, area reclaim.
55C---------- Barco	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell, frost action.	Moderate: thin layer, area reclaim.
56C---------- Bolivar	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell, frost action.	Moderate: thin layer, area reclaim.
56D---------- Bolivar	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.	Moderate: slope, thin layer, area reclaim.
58, 58B2, 58B3---- Hartwell	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
60B, 60B2--------- Barden	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
63B---------- Union	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength.	Moderate: wetness.
63C---------- Union	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength.	Moderate: wetness.
66C---------- Doniphan	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Severe: small stones.
66D---------- Doniphan	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Severe: small stones.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
67C---------- Bardley	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: low strength.	Moderate: small stones.
67E---------- Bardley	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: low strength, slope.	Severe: small stones, slope.
68C---------- Eldon	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.	Moderate: small stones, large stones.
68D---------- Eldon	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, frost action, shrink-swell.	Moderate: small stones, large stones, slope.
72C*: Gasconade--------	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: large stones, thin layer.
Rock outcrop.						
72F*: Gasconade--------	Severe: depth to rock, large stones, slope.	Severe: slope, depth to rock, large stones.	Severe: depth to rock, slope, large stones.	Severe: slope, depth to rock, large stones.	Severe: depth to rock, slope, large stones.	Severe: large stones, slope, thin layer.
Rock outcrop.						
74C*: Knobby----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: droughty, thin layer.
Rock outcrop.						
74F*: Knobby----------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: droughty, slope, thin layer.
Rock outcrop.						
80---------- Osage	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
8*: Pits.					
Dumps.					
9. Udorthents					
13B---------- Sampsel	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
13C---------- Sampsel	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
15---------- Ashton	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
20B---------- Creldon	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness, too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
20C---------- Creldon	Severe: wetness, percs slowly.	Severe: seepage, slope, wetness.	Severe: seepage, wetness, too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
23F---------- Goss	Severe: slope.	Severe: seepage, slope.	Severe: slope, too clayey, large stones.	Severe: slope.	Poor: too clayey, small stones, slope.
30---------- Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
32---------- Racket	Severe: flooding, wetness.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding.	Fair: too clayey, thin layer.
33---------- Quarles	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
35. Aquents					

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
50B---------- McGirk	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
51C---------- Claiborne	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey, small stones.
52B---------- Deepwater	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Slight----------	Fair: too clayey, wetness.
52C---------- Deepwater	Severe: wetness.	Severe: slope, wetness.	Moderate: wetness, too clayey.	Slight----------	Fair: too clayey, wetness.
53B---------- Mandeville	Severe: thin layer, seepage.	Severe: seepage.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
54---------- Moniteau	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
55B---------- Barco	Severe: thin layer, seepage.	Severe: seepage.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
55C---------- Barco	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
56C---------- Bolivar	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
56D---------- Bolivar	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: seepage, slope.	Poor: area reclaim, thin layer.
58---------- Hartwell	Severe: wetness, percs slowly.	Slight----------	Severe: wetness.	Severe: wetness.	Poor: wetness.
58B2, 58B3---------- Hartwell	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Poor: wetness.
60E, 60B2---------- Barden	Severe: wetness, percs slowly.	Moderate: slope.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.
63B---------- Union	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Moderate: wetness.	Poor: too clayey.
63C---------- Union	Severe: wetness, percs slowly.	Severe: slope, wetness.	Severe: wetness, too clayey.	Moderate: wetness.	Poor: too clayey.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
66C---------- Doniphan	Moderate: percs slowly.	Moderate: seepage, slope, large stones.	Severe: too clayey.	Slight----------	Poor: too clayey, hard to pack.
66D---------- Doniphan	Moderate: percs slowly, slope.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
67C---------- Bardley	Severe: thin layer, seepage.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage.	Moderate: seepage.	Poor: area reclaim, too clayey, hard to pack.
67E---------- Bardley	Severe: thin layer, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: slope.	Poor: area reclaim, too clayey, hard to pack.
68C---------- Eldon	Moderate: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight----------	Poor: too clayey, hard to pack.
68D---------- Eldon	Moderate: percs slowly, slope.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
72C*: Gasconade----------	Severe: thin layer, seepage.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: area reclaim, too clayey, large stones.
Rock outcrop.					
72F*: Gasconade----------	Severe: thin layer, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, too clayey, large stones.
Rock outcrop.					
74C*: Knobby----------	Severe: thin layer, seepage.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: area reclaim, thin layer.
Rock outcrop.					
74F*: Knobby----------	Severe: thin layer, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope, thin layer.
Rock outcrop.					

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
80---------- Osage	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
8*: Pits.				
Dumps.				
9. Udorthents				
13B, 13C Sampsel	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
15 Ashton	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
20B, 20C Creldon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
23F Goss	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
30 Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
32 Racket	Good	Probable	Probable	Poor: area reclaim.
33 Quarles	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
35. Aquents				
50B McGirk	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
51C Claiborne	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
52B, 52C Deepwater	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
53B Mandeville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
54---------- Moniteau	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
55B, 55C---------- Barco	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
56C, 56D---------- Bolivar	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
58, 58B2, 58B3-------- Hartwell	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
60B, 60B2---------- Barden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
63E, 63C---------- Union	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, small stones, area reclaim.
66C, 66D---------- Doniphan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, too clayey.
67C---------- Bardley	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, small stones.
67E---------- Bardley	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, small stones, slope.
68C, 68D---------- Eldon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
72C*, 72F*: Gasconade---------- Rock outcrop.	Poor: area reclaim, large stones, thin layer.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: area reclaim, large stones, thin layer.
74C*: Knobby---------- Rock outcrop.	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
74F*: Knobby	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
Rock outcrop.				
80--- Osage	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
3*: Pits.						
Dumps.						
9. Udorthents						
13B, 13C---- Sampsel	Moderate: slope.	Severe: hard to pack, wetness.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
15---- Ashton	Moderate: seepage.	Severe: piping.	Deep to water	Flooding----	Erodes easily	Erodes easily.
20B, 20C---- Creldon	Severe: seepage.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, rooting depth.
23F---- Goss	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
30---- Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding----	Favorable----	Favorable.
32---- Racket	Severe: seepage.	Severe: piping.	Deep to water	Flooding----	Favorable----	Favorable.
33---- Quarles	Slight----	Severe: wetness.	Percs slowly, flooding.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, percs slowly.
35. Aquents						
50B---- McGirk	Moderate: slope.	Severe: wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Wetness, erodes easily.
51C---- Claiborne	Moderate: seepage, slope.	Moderate: piping, thin layer.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
52B, 52C---- Deepwater	Moderate: seepage, slope.	Slight----	Deep to water	Slope----	Erodes easily	Erodes easily.
53B---- Mandeville	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope, thin layer, erodes easily.	Area reclaim, erodes easily.	Erodes easily, area reclaim.
54---- Moniteau	Slight----	Severe: wetness.	Frost action---	Wetness, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
55B, 55C---------- Barco	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope, thin layer.	Area reclaim---	Area reclaim.
56C---------- Bolivar	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope, soil blowing, thin layer.	Area reclaim, soil blowing.	Area reclaim.
56D---------- Bolivar	Severe: slope.	Severe: thin layer.	Deep to water	Slope, soil blowing, thin layer.	Slope, area reclaim, soil blowing.	Slope, area reclaim.
58, 58B2, 58B3---- Hartwell	Slight---------	Severe: wetness.	Percs slowly---	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
60B, 60B2--------- Barden	Moderate: slope.	Moderate: wetness.	Percs slowly, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
63B, 63C---------- Union	Moderate: seepage, slope.	Moderate: thin layer, wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, rooting depth.
66C---------- Doniphan	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Droughty, slope.	Favorable------	Droughty.
66D---------- Doniphan	Severe: slope.	Moderate: hard to pack.	Deep to water	Droughty, slope.	Slope----------	Slope, droughty.
67C---------- Bardley	Moderate: seepage, depth to rock, slope.	Severe: piping, hard to pack.	Deep to water	Slope, droughty, thin layer.	Depth to rock, area reclaim.	Droughty, depth to rock.
67E---------- Bardley	Severe: slope.	Severe: piping, hard to pack.	Deep to water	Slope, droughty, thin layer.	Slope, depth to rock, area reclaim.	Slope, droughty, depth to rock.
68C---------- Eldon	Moderate: seepage, slope.	Severe: hard to pack.	Deep to water	Droughty, slope.	Large stones---	Large stones, droughty.
68D---------- Eldon	Severe: slope.	Severe: hard to pack.	Deep to water	Droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
72C*: Gasconade--------	Severe: depth to rock, seepage.	Severe: large stones, thin layer.	Deep to water	Slope, large stones, droughty.	Large stones, depth to rock.	Large stones, droughty.
Rock outcrop.						
72F*: Gasconade--------	Severe: depth to rock, seepage, slope.	Severe: large stones, thin layer.	Deep to water	Slope, large stones, droughty.	Slope, large stones, depth to rock.	Large stones, slope, droughty.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
72F*: Rock outcrop.						
74C*: Knobby	Severe: depth to rock, seepage.	Severe: thin layer.	Deep to water	Slope, large stones, thin layer.	Large stones, depth to rock.	Large stones, depth to rock.
Rock outcrop.						
74F*: Knobby	Severe: depth to rock, seepage, slope.	Severe: thin layer.	Deep to water	Slope, large stones, thin layer.	Slope, large stones, depth to rock.	Slope, large stones, depth to rock.
Rock outcrop.						
80 Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness	Wetness, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
8*: Pits.											
Dumps.											
9. Udorthents											
13B, 13C---------- Sampsel	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
	10-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	95-100	95-100	52-75	35-47
15---------- Ashton	0-10	Silt loam--------	ML	A-4	0	95-100	90-100	75-100	60-95	<35	NP-10
	10-49	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0	95-100	90-100	85-100	80-100	25-42	5-20
	49-60	Silt loam, loam, fine sandy loam.	ML, CL, SM, CL-ML	A-4, A-6	0-5	90-100	85-100	65-95	40-90	<40	NP-20
20B, 20C---------- Creldon	0-14	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	95-100	90-100	85-95	20-40	2-15
	14-26	Silty clay loam, silty clay.	CH	A-7	0	90-100	90-100	85-95	80-95	50-60	25-35
	26-33	Very cherty silty clay loam, extremely cherty silty clay loam.	GC	A-2, A-6, A-7	0-25	30-65	30-60	25-55	20-50	35-45	15-25
	33-60	Very cherty clay, extremely cherty clay, cherty clay.	GC, CH, SC	A-2, A-7	5-35	45-75	40-75	35-70	30-65	55-80	35-60
23F---------- Goss	0-5	Cherty silt loam	ML, CL, CL-ML	A-4	0-10	65-85	65-75	65-75	65-75	20-30	2-10
	5-13	Very cherty silty clay loam, very cherty silt loam.	GM, GC, GM-GC	A-2	10-40	40-60	35-55	30-50	25-35	20-30	2-10
	13-60	Extremely cherty silty clay loam, very cherty silty clay, very cherty clay.	GC, SC	A-7, A-2-7	10-45	45-70	20-65	20-50	20-45	50-70	30-40
30---------- Verdigris	0-27	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-35	2-13
	27-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
32---------- Racket	0-7	Silt loam--------	CL-ML, CL	A-4, A-6	0	90-100	85-100	75-95	55-85	25-35	5-12
	7-42	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	90-100	85-100	75-95	55-95	25-40	5-20
	42-60	Stratified gravelly loamy sand to extremely cherty sand.	GM, GP-GM, SM, SP-SM	A-1	0-15	30-65	20-65	10-50	5-20	<30	NP-5

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
33---------- Quarles	0-9	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	85-100	30-40	8-18
	9-18	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	85-100	30-40	8-18
	18-60	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	40-60	20-35
35. Aquents											
50B---------- McGirk	0-14	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	90-100	85-100	25-40	5-15
	14-21	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	15-30
	21-54	Silty clay, silty clay loam.	CH, MH	A-7	0	100	100	95-100	90-100	50-75	25-40
	54-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	90-100	85-100	35-50	11-25
51C---------- Claiborne	0-10	Silt loam--------	ML, CL, CL-ML	A-4	0-5	85-100	70-95	65-90	55-80	24-35	4-10
	10-60	Silty clay loam, cherty silty clay loam.	CL	A-4, A-6	0-5	85-100	70-95	65-90	60-80	28-40	8-20
52B, 52C---------- Deepwater	0-11	Silt loam--------	CL	A-4, A-6	0	100	100	90-100	70-95	25-40	7-15
	11-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	85-100	80-100	75-95	35-50	15-26
53B---------- Mandeville	0-13	Silt loam--------	CL, CL-ML	A-4, A-6	0	90-100	90-100	90-100	85-95	25-35	5-15
	13-26	Silty clay loam, silt loam, loam.	CL	A-6	0-5	80-90	80-90	70-85	65-80	30-40	11-20
	26-32	Channery silty clay loam, channery silt loam, channery loam.	CL	A-6	0-5	60-85	60-85	55-80	50-75	30-40	11-20
	32-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
54---------- Moniteau	0-14	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	90-100	85-100	25-35	5-15
	14-49	Silty clay loam	CL	A-6, A-7	0	100	100	85-100	80-95	30-45	15-25
	49-60	Silt loam, silty clay loam.	CL-ML, CL, ML	A-4, A-6	0	100	100	85-100	75-100	25-40	5-15
55B, 55C---------- Barco	0-13	Loam----------	ML, CL-ML, CL	A-4, A-6	0	100	100	85-95	50-75	22-35	2-14
	13-26	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-5	85-100	75-100	75-100	45-80	25-40	11-22
	26-33	Weathered bedrock	---	---	---	---	---	---	---	---	---
	33	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
56C, 56D---------- Bolivar	0-8	Fine sandy loam	ML, SM	A-4	0	100	90-100	70-95	40-55	20-30	NP-5
	8-26	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-10	85-100	85-100	70-95	45-80	25-40	10-25
	26-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
58, 58B2---------- Hartwell	0-13	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	20-35	5-15
	13-28	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-65	30-40
	28-60	Silt loam, silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	20-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
58B3---------- Hartwell	0-5	Silty clay loam	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	20-35	5-15
	5-12	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-65	30-40
	12-60	Silt loam, silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	20-25
60B, 60B2--------- Barden	0-11	Silt loam---------	CL	A-4, A-6	0	100	100	90-100	75-85	25-35	8-15
	11-14	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-90	30-45	15-25
	14-23	Silty clay, silty clay loam, clay loam.	CL, CH	A-7	0	100	100	90-100	80-95	40-60	25-40
	23-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	90-100	75-95	30-45	15-25
63B, 63C--------- Union	0-7	Silt loam---------	CL-ML, CL	A-4, A-6	0-5	85-100	85-100	80-95	60-75	22-35	5-15
	7-27	Silty clay loam, silty clay.	CL	A-6, A-7	0-10	85-95	80-90	75-85	65-75	35-50	15-30
	27-42	Silt loam, cherty silt loam, very cherty silty clay loam.	CL, SC	A-7, A-6, A-4, A-2	0-20	85-95	40-90	35-85	30-75	25-45	8-22
	42-60	Clay, very cherty clay, cherty clay.	CL, CH, SC, GC	A-7	0-20	65-95	50-90	45-65	40-60	45-80	25-45
66C, 66D--------- Doniphan	0-8	Cherty silt loam	CL-ML, GM, GM-GC, SM-SC	A-4	5-30	50-80	35-70	35-65	35-60	20-30	2-8
	8-18	Cherty clay, clay	CH, MH	A-7	0-5	85-100	60-100	55-100	50-90	51-70	25-35
	18-60	Clay----------	CH, MH	A-7	0-5	90-100	90-100	85-100	70-95	51-70	25-35
67C---------- Bardley	0-10	Cherty silt loam	GC, CL, SC, CL-ML	A-6, A-4	0-15	60-90	50-75	50-70	45-65	25-35	5-15
	10-30	Silty clay, clay, cherty clay.	GM, SM, MH	A-7	0-10	70-95	50-95	50-90	40-85	50-70	20-35
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
67E---------- Bardley	0-10	Very cherty silt loam, cherty silty clay loam.	GC, CL, SC	A-6, A-2	0-15	40-90	30-75	30-70	25-65	30-40	10-20
	10-30	Silty clay, clay, gravelly clay.	GM, SM, MH	A-7	0-10	70-95	50-95	50-90	40-85	50-70	20-35
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
68C, 68D--------- Eldon	0-10	Cherty silt loam	ML, CL-ML, CL	A-4	5-25	70-95	65-90	60-85	55-80	20-30	2-8
	10-28	Very cherty silty clay loam, very cherty silty clay.	GC, GP-GC	A-2-7, A-7	5-15	20-50	15-45	15-40	10-40	40-50	25-30
	28-60	Silty clay, clay, cherty silty clay.	CL, CH, ML, MH	A-7	0-15	80-100	65-100	65-100	65-100	45-95	25-50

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
72C*, 72F*:											
Gasconade-------	0-8	Flaggy silty clay loam.	CL	A-6	20-50	75-90	70-85	60-75	55-65	30-40	15-25
	8-15	Flaggy silty clay, flaggy clay, very flaggy silty clay loam.	GC	A-2-7	20-70	45-55	40-50	30-40	20-35	55-65	35-45
	15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
74C*, 74F*:											
Knobby----------	0-3	Gravelly loam----	CL-ML, CL, GC, GM-GC	A-4	15-25	65-85	60-85	50-75	40-65	20-30	4-10
	3-7	Very gravelly sandy loam, very gravelly loam, very cobbly sandy loam.	GC, SC, GM-GC, SM-SC	A-2-4, A-4, A-1-b	15-40	56-75	45-75	35-65	20-50	20-30	4-10
	7	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
80--------------	0-8	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
Osage	8-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-50

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
8*:											
Pits.											
Dumps.											
9.											
Udorthents											
13B, 13C---------	0-10	27-35	1.30-1.50	0.2-0.6	0.21-0.24	5.6-7.3	Moderate-----	0.37	3-2	7	3-4
Sampsel	10-60	35-60	1.40-1.60	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.37			
15---------------	0-10	10-25	1.20-1.40	0.6-2.0	0.16-0.23	5.6-7.3	Low----------	0.32	5	5	2-4
Ashton	10-49	18-34	1.20-1.50	0.6-2.0	0.18-0.23	5.6-7.3	Low----------	0.43			
	49-60	10-40	1.25-1.55	0.6-2.0	0.14-0.20	5.6-7.3	Low----------	0.43			
20B, 20C---------	0-14	10-25	1.20-1.40	0.6-2.0	0.22-0.24	4.5-7.3	Low----------	0.32	4-3	5	1-3
Creldon	14-26	35-45	1.30-1.50	0.2-0.6	0.12-0.17	4.5-6.5	Moderate-----	0.32			
	26-33	25-35	1.60-1.85	<0.06	0.05-0.12	3.6-5.5	Low----------	0.43			
	33-60	40-70	1.30-1.55	2.0-6.0	0.04-0.10	4.5-6.0	High---------	0.32			
23F---------------	0-5	10-27	1.10-1.30	2.0-6.0	0.06-0.17	4.5-6.5	Low----------	0.24	2	8	1-2
Goss	5-13	20-30	1.10-1.30	2.0-6.0	0.06-0.10	4.5-6.0	Low----------	0.10			
	13-60	35-60	1.30-1.50	0.6-2.0	0.04-0.09	4.5-6.0	Moderate-----	0.10			
30---------------	0-27	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.32	5	6	2-4
Verdigris	27-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	Moderate-----	0.32			
32---------------	0-7	15-27	1.25-1.45	0.6-2.0	0.18-0.24	6.1-7.3	Low----------	0.32	5	6	2-3
Racket	7-42	18-35	1.25-1.45	0.6-2.0	0.14-0.20	6.1-7.3	Moderate-----	0.32			
	42-60	3-10	1.35-1.55	6.0-20.0	0.01-0.04	6.1-7.3	Low----------	0.10			
33---------------	0-9	20-27	1.20-1.40	0.2-0.6	0.22-0.24	5.1-7.3	Low----------	0.32	3	6	1-3
Quarles	9-18	20-27	1.20-1.40	0.2-0.6	0.22-0.24	4.5-6.0	Low----------	0.32			
	18-60	35-50	1.40-1.60	0.06-0.2	0.12-0.20	4.5-6.5	High---------	0.32			
35.											
Aquents											
50B---------------	0-14	15-27	1.30-1.45	0.6-2.0	0.22-0.24	5.1-6.5	Low----------	0.43	3	6	1-2
McGirk	14-21	27-40	1.30-1.40	0.2-0.6	0.18-0.20	4.5-5.5	Moderate-----	0.43			
	21-54	35-50	1.25-1.35	0.06-0.2	0.10-0.18	4.5-6.0	High---------	0.32			
	54-60	20-35	1.30-1.40	0.2-0.6	0.14-0.18	4.5-6.0	Moderate-----	0.32			
51C---------------	0-10	20-27	1.30-1.50	0.6-2.0	0.17-0.21	4.5-6.0	Low----------	0.37	5	6	1-3
Claiborne	10-60	27-35	1.35-1.55	0.6-2.0	0.17-0.20	4.5-5.5	Moderate-----	0.32			
52B, 52C---------	0-11	15-27	1.20-1.40	0.6-2.0	0.21-0.24	5.1-7.3	Low----------	0.32	5	6	2-5
Deepwater	11-60	27-35	1.40-1.60	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
53B---------------	0-13	15-27	1.35-1.45	0.6-2.0	0.22-0.24	5.1-6.5	Low----------	0.37	4	6	1-2
Mandeville	13-26	20-32	1.30-1.40	0.6-2.0	0.14-0.20	4.5-6.0	Low----------	0.37			
	26-32	20-32	1.30-1.40	0.6-2.0	0.12-0.18	4.5-6.0	Low----------	0.37			
	32-60	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
54----------	0-14	18-27	1.20-1.40	0.6-2.0	0.21-0.23	5.1-6.5	Low----------	0.43	3	6	1-2
Moniteau	14-49	27-35	1.30-1.50	0.2-0.6	0.18-0.20	4.5-6.0	Moderate-----	0.43			
	49-60	18-30	1.25-1.45	0.2-0.6	0.20-0.22	4.5-6.5	Low----------	0.43			
55E, 55C----------	0-13	10-25	1.20-1.45	2.0-6.0	0.16-0.21	5.1-7.3	Low----------	0.32	4	5	1-3
Barco	13-26	18-35	1.40-1.60	0.6-2.0	0.12-0.16	4.5-6.5	Moderate-----	0.32			
	26-33	---	---	---	---	---	----------	---			
	33	---	---	---	---	---	----------	---			
56C, 56D----------	0-8	12-18	1.20-1.45	2.0-6.0	0.16-0.18	5.1-6.5	Low----------	0.24	4	3	.5-2
Bolivar	8-26	20-35	1.30-1.50	0.6-2.0	0.12-0.16	4.5-6.0	Moderate-----	0.32			
	26-60	---	---	---	---	---	----------	---			
58, 58B2----------	0-13	15-27	1.30-1.40	0.2-0.6	0.22-0.24	5.1-7.3	Low----------	0.43	3	6	2-4
Hartwell	13-28	40-55	1.30-1.40	0.06-0.2	0.09-0.13	5.1-6.5	High---------	0.32			
	28-60	25-45	1.30-1.40	0.06-0.2	0.18-0.20	5.1-7.3	Moderate-----	0.43			
58B3----------	0-5	15-32	1.30-1.40	0.2-0.6	0.22-0.24	5.1-7.3	Low----------	0.43	3	6	.5-1
Hartwell	5-12	40-55	1.30-1.40	0.06-0.2	0.09-0.13	5.1-6.5	High---------	0.32			
	12-60	25-45	1.30-1.40	0.06-0.2	0.18-0.20	5.1-7.3	Moderate-----	0.43			
60B, 60B2---------	0-11	15-27	1.40-1.50	0.6-2.0	0.21-0.24	5.1-7.3	Low----------	0.37	4	6	1-3
Barden	11-14	28-35	1.35-1.45	0.2-0.6	0.18-0.20	4.5-6.5	Moderate-----	0.37			
	14-23	36-55	1.25-1.40	0.06-0.2	0.11-0.19	4.5-6.5	High---------	0.37			
	23-60	28-40	1.30-1.45	0.2-0.6	0.10-0.14	4.5-6.5	Moderate-----	0.37			
63B, 63C----------	0-7	10-27	1.35-1.45	0.6-2.0	0.18-0.22	5.6-6.5	Moderate-----	0.43	4	5	.5-2
Union	7-27	27-45	1.30-1.40	0.6-2.0	0.14-0.19	4.5-5.5	Moderate-----	0.43			
	27-42	15-35	1.60-1.90	0.06-0.2	0.01-0.05	3.6-5.0	Moderate-----	0.43			
	42-60	40-80	1.30-1.40	0.2-0.6	0.02-0.06	4.5-6.0	High---------	0.43			
66C, 66D----------	0-8	18-27	1.10-1.30	2.0-6.0	0.08-0.15	4.5-6.5	Low----------	0.28	5	8	.5-2
Doniphan	8-18	48-70	1.20-1.40	0.6-2.0	0.08-0.10	3.6-5.5	Moderate-----	0.28			
	18-60	48-70	1.20-1.40	0.6-2.0	0.08-0.10	3.6-5.5	Moderate-----	0.28			
67C----------	0-10	18-27	1.40-1.55	0.6-2.0	0.12-0.17	4.5-6.5	Low----------	0.28	4	8	.5-2
Bardley	10-30	50-85	1.20-1.40	0.6-2.0	0.08-0.12	4.5-7.3	Moderate-----	0.28			
	30	---	---	---	---	---	----------	---			
67E----------	0-10	25-35	1.40-1.55	0.6-2.0	0.12-0.17	4.5-6.5	Moderate-----	0.28	3	8	.5-2
Bardley	10-30	50-85	1.20-1.40	0.6-2.0	0.08-0.12	4.5-7.3	Moderate-----	0.28			
	30	---	---	---	---	---	----------	---			
68C, 68D----------	0-10	15-27	1.40-1.55	2.0-6.0	0.13-0.18	4.5-7.3	Low----------	0.24	2	8	1-3
Eldon	10-28	35-50	1.35-1.45	0.6-2.0	0.03-0.08	4.5-7.3	Moderate-----	0.24			
	28-60	35-95	1.35-1.45	0.6-2.0	0.10-0.14	4.5-7.8	Moderate-----	0.24			
72C*, 72F*:											
Gasconade-------	0-8	35-40	1.35-1.50	0.6-2.0	0.10-0.12	6.1-7.8	Moderate-----	0.20	2	8	2-4
	8-15	35-60	1.45-1.70	0.2-0.6	0.05-0.07	6.1-7.8	Moderate-----	0.20			
	15	---	---	---	---	---	----------	---			
Rock outcrop.											
74C*, 74F*:											
Knobby----------	0-3	10-18	1.30-1.50	0.6-2.0	0.13-0.17	6.6-7.8	Low----------	0.24	1	8	1-2
	3-7	10-18	1.30-1.50	0.6-2.0	0.07-0.11	6.6-7.8	Low----------	0.17			
	7	---	---	---	---	---	----------	---			
Rock outcrop.											

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
80----------	0-8	35-40	1.45-1.65	<0.06	0.21-0.23	5.1-7.3	High---------	0.28	5	4	1-4
Osage	8-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	Very high----	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
8*: Pits. Dumps.												
9. Udorthents												
13B, 13C---------- Sampsel	D	None--------	---	---	0-1.5	Perched	Nov-Apr	>60	---	High-----	High-----	Low.
15---------- Ashton	B	Occasional	Very brief	Nov-May	>6.0	---	---	>60	---	---	Low------	Low.
20B, 20C---------- Creldon	C	None--------	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	Moderate	High-----	High.
23F---------- Goss	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
30---------- Verdigris	B	Occasional	Very brief	Nov-May	>6.0	---	---	>60	---	---	Low------	Low.
32---------- Racket	B	Occasional	Very brief	Nov-May	3.5-6.0	Apparent	Nov-Apr	>60	---	Moderate	Moderate	Low.
33---------- Quarles	D	Occasional	Brief-----	Nov-May	0-1.5	Perched	Nov-Apr	>60	---	---	High-----	Moderate.
35. Aquents												
50B---------- McGirk	D	None--------	---	---	0.5-2.0	Perched	Nov-Apr	>60	---	High-----	High-----	High.
51C---------- Claiborne	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate.
52B, 52C---------- Deepwater	B	None--------	---	---	3.0-4.5	Perched	Nov-Apr	>60	---	---	High-----	Moderate.
53B---------- Mandeville	B	None--------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low------	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FFATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
54---------- Moniteau	C/D	Rare--------	---	---	0-1.0	Apparent	Nov-Apr	>60	---	High-----	High-----	High.
55B, 55C---------- Barco	B	None--------	---	---	>6.0	---	---	20-40	Soft	---	Low------	Moderate.
56C, 56D---------- Bolivar	B	None--------	---	---	>6.0	---	---	20-40	Soft	---	Low------	Moderate.
58, 58B2, 58B3---- Hartwell	D	None--------	---	---	0.5-1.5	Perched	Nov-Apr	>60	---	---	High-----	Moderate.
60B, 60B2---------- Barder	C	None--------	---	---	2.0-3.0	Perched	Nov-Apr	>60	---	---	High-----	Moderate.
63B, 63C---------- Union	C	None--------	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	Moderate	High-----	High.
66C, 66D---------- Doniphan	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	High.
67C, 67E---------- Bardley	B	None--------	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate	Moderate.
68C, 68D---------- Eldon	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
72C*, 72F*: Gasconade--------	D	None--------	---	---	>6.0	---	---	4-20	Hard	Moderate	High-----	Low.
Rock outcrop.												
74C*, 74F*: Knobby----------	D	None--------	---	---	>6.0	---	---	4-15	Hard	Low------	Low------	Low.
Rock outcrop.												
80---------- Osage	D	Occasional	Very brief to long.	Nov-Apr	0-1.0	Apparent	Nov-Apr	>60	---	---	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aquents	Loamy, mixed, mesic Typic Fluvaquents
Ashton	Fine-silty, mixed, mesic Mollic Hapludalfs
Barco	Fine-loamy, mixed, thermic Mollic Hapludalfs
Barden	Fine, mixed, thermic Aquollic Hapludalfs
Bardley	Very fine, mixed, mesic Typic Hapludalfs
Bolivar	Fine-loamy, mixed, thermic Ultic Hapludalfs
Claiborne	Fine-loamy, siliceous, mesic Typic Paleudults
Creldon	Fine, mixed, mesic Mollic Fragiudalfs
Deepwater	Fine-silty, mixed, thermic Typic Argiudolls
Doniphan	Clayey, mixed, mesic Typic Paleudults
Eldon	Clayey-skeletal, mixed, mesic Mollic Paleudalfs
Gasconade	Clayey-skeletal, mixed, mesic Lithic Hapludolls
Goss	Clayey-skeletal, mixed, mesic Typic Paleudalfs
Hartwell	Fine, mixed, thermic Typic Argialbolls
Knobby	Loamy-skeletal, mixed, mesic Lithic Hapludolls
Mandeville	Fine-loamy, mixed, mesic Typic Hapludalfs
McGirk	Fine, montmorillonitic, mesic, sloping Typic Ochraqualfs
Moniteau	Fine-silty, mixed, mesic Typic Ochraqualfs
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Quarles	Fine, mixed, thermic Mollic Ochraqualfs
Racket	Fine-loamy, mixed, mesic Cumulic Hapludolls
Sampsel	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Udorthents	Clayey, mixed, mesic Typic Udorthents
Union	Fine, mixed, mesic Typic Fragiudalfs
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls

*U.S. G.P.O. 1990-256-636

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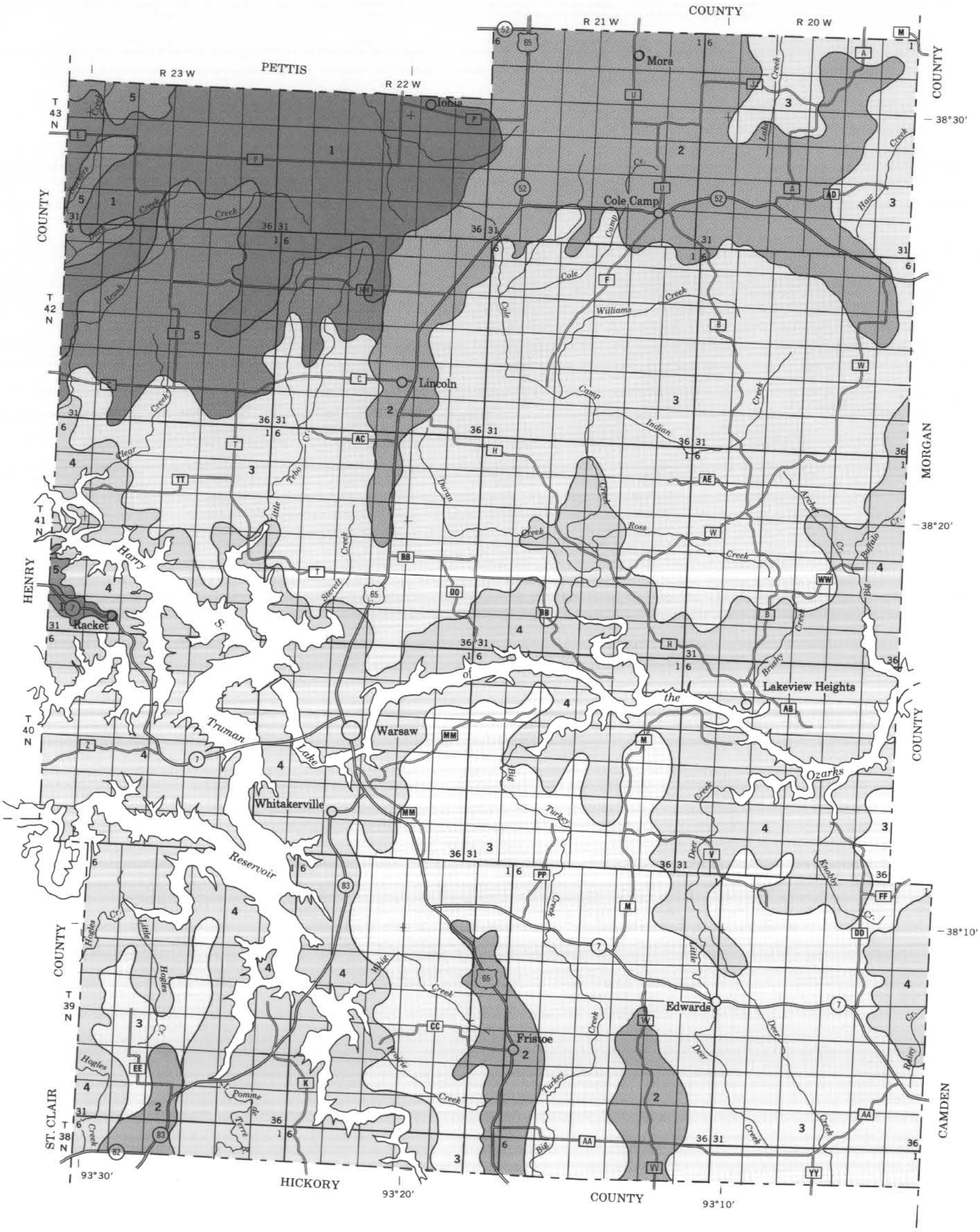

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SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

LEGEND

1 — HARTWELL-BARDEN ASSOCIATION: Deep, nearly level to gently sloping, somewhat poorly drained and moderately well drained soils; on uplands

2 — ELDON-CRELDON-BARDEN ASSOCIATION: Deep, very gently sloping to strongly sloping, well drained and moderately well drained soils; on uplands

3 — GOSS-BARDLEY-DONIPHAN ASSOCIATION: Moderately deep and deep, gently sloping to very steep, well drained soils; on uplands

4 — BARDLEY-GASCONADE-GOSS ASSOCIATION: Shallow to deep, gently sloping to very steep, well drained and somewhat excessively drained soils; on uplands

5 — BARDEN-BARCO-DEEPWATER ASSOCIATION: Deep and moderately deep, very gently sloping to moderately sloping, moderately well drained and well drained soils; on uplands

Compiled 1988

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISSOURI AGRICULTURAL EXPERIMENT STATION

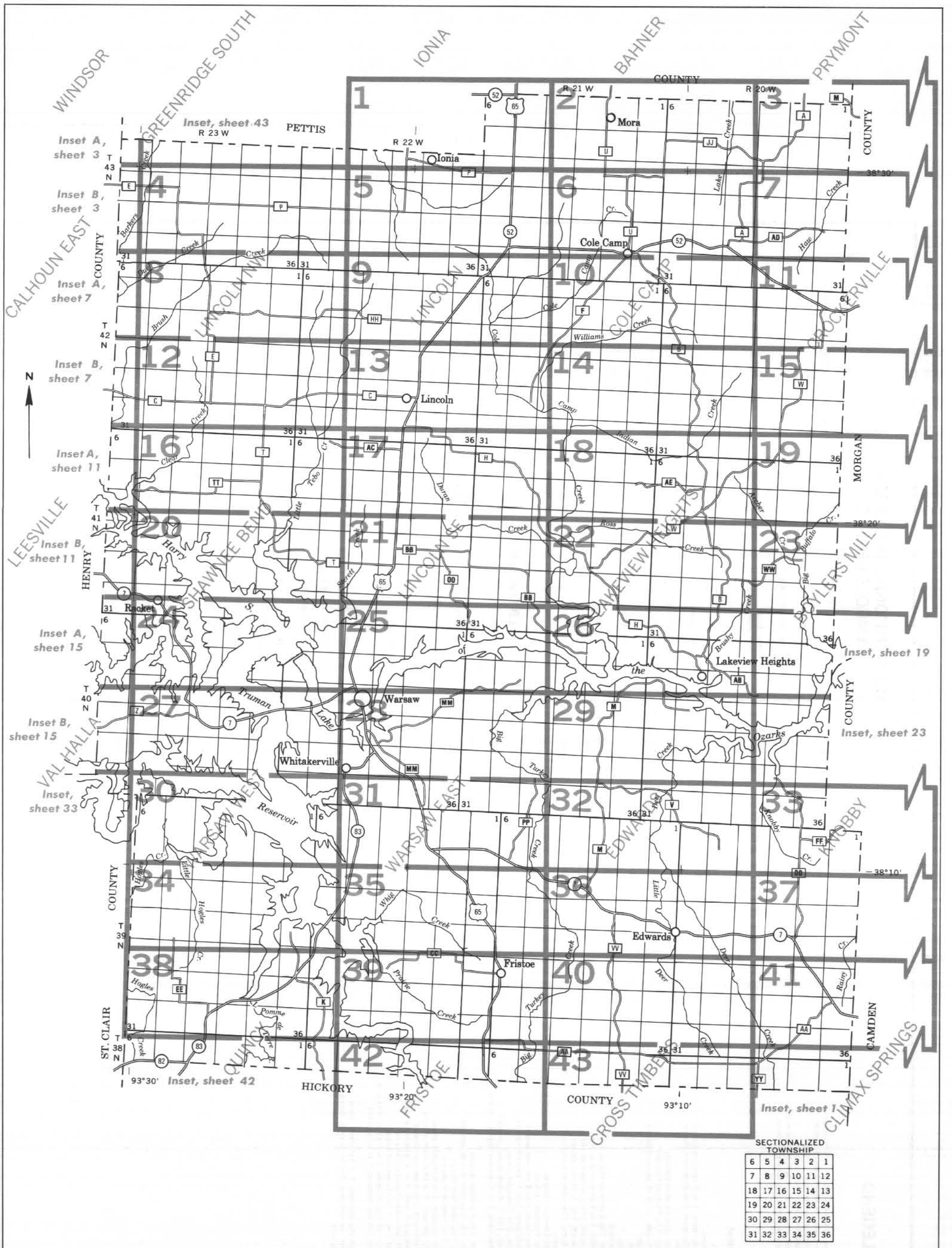
GENERAL SOIL MAP

BENTON COUNTY, MISSOURI

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

General Soil Map Welcome Page Manuscript

INDEX TO MAP SHEETS

BENTON COUNTY, MISSOURI

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is eroded and 3 that it is severely eroded.

SYMBOL	NAME
8	Pits and Dumps
9	Udorthents, clayey
13B	Sampsel silty clay loam, 2 to 5 percent slopes
13C	Sampsel silty clay loam, 5 to 9 percent slopes
15	Ashton silt loam
20B	Creldon silt loam, 2 to 5 percent slopes
20C	Creldon silt loam, 5 to 9 percent slopes
23F	Goss cherty silt loam, 14 to 45 percent slopes
30	Verdigris silt loam
32	Racket silt loam
33	Quarles silt loam
35	Aquents, nearly level
50B	McGirk silt loam, 2 to 5 percent slopes
51C	Claiborne silt loam, 5 to 9 percent slopes
52B	Deepwater silt loam, 2 to 5 percent slopes
52C	Deepwater silt loam, 5 to 9 percent slopes
53B	Mandeville silt loam, 2 to 5 percent slopes
54	Moniteau silt loam
55B	Barco loam, 2 to 5 percent slopes
55C	Barco loam, 5 to 9 percent slopes
56C	Bolivar fine sandy loam, 5 to 9 percent slopes
56D	Bolivar fine sandy loam, 9 to 14 percent slopes
58	Hartwell silt loam, 0 to 2 percent slopes
58B2	Hartwell silt loam, 1 to 3 percent slopes, eroded
58B3	Hartwell silty clay loam, 1 to 3 percent slopes, severely eroded
60B	Barden silt loam, 1 to 5 percent slopes
60B2	Barden silt loam, 1 to 5 percent slopes, eroded
63B	Union silt loam, 2 to 5 percent slopes
63C	Union silt loam, 5 to 9 percent slopes
66C	Doniphan cherty silt loam, 3 to 9 percent slopes
66D	Doniphan cherty silt loam, 9 to 14 percent slopes
67C	Bardley cherty silt loam, 3 to 9 percent slopes
67E	Bardley very cherty silt loam, 9 to 35 percent slopes
68C	Eldon cherty silt loam, 3 to 9 percent slopes
68D	Eldon cherty silt loam, 9 to 14 percent slopes
72C	Gasconade-Rock outcrop complex, 2 to 9 percent slopes
72F	Gasconade-Rock outcrop complex, 9 to 50 percent slopes
74C	Knobby-Rock outcrop complex, 3 to 9 percent slopes
74F	Knobby-Rock outcrop complex, 9 to 50 percent slopes
80	Osage silty clay loam

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CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

National, state or province

County or parish

Minor civil division

Reservation (national forest or park, state forest or park, and large airport)

Land grant

Limit of soil survey (label)

Field sheet matchline and neatline

AD HOC BOUNDARY (label)

Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

Divided (median shown if scale permits)

Other roads

Trail

ROAD EMBLEM & DESIGNATIONS

Interstate

Federal

State

County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

Without road

With road

With railroad

DAMS

Large (to scale)

Medium or Small

PITS

Gravel pit

Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

Farmstead, house (omit in urban areas)

Church

School

Indian mound (label)

Located object (label)

Tank (label)

Wells, oil or gas

Windmill

Kitchen midden

WATER FEATURES

DRAINAGE

Perennial, double line

Perennial, single line

Intermittent

Drainage end

Canals or ditches

Double-line (label)

Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

Perennial

Intermittent

MISCELLANEOUS WATER FEATURES

Marsh or swamp

Spring

Well, artesian

Well, irrigation

Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

Bedrock (points down slope)

Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

Blowout

Clay spot

Gravelly spot

Gumbo, slick or scabby spot (sodic)

Dumps and other similar non soil areas

Prominent hill or peak

Rock outcrop (includes sandstone and shale)

Saline spot

Sandy spot

Severely eroded spot

Slide or slip (tips point upslope)

Stony spot, very stony spot

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1 0.5 0 1 2 KILOMETERS

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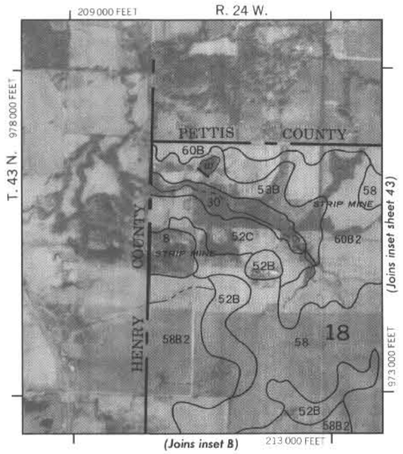
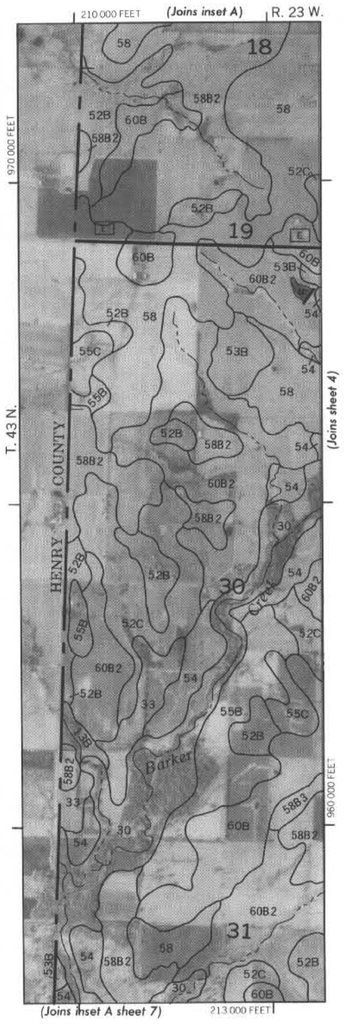


4000 AND 5000-FOOT GRID TICKS

INSET B



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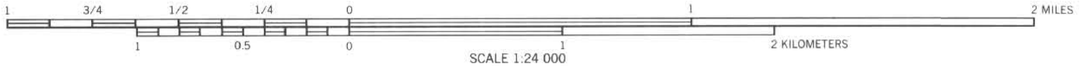

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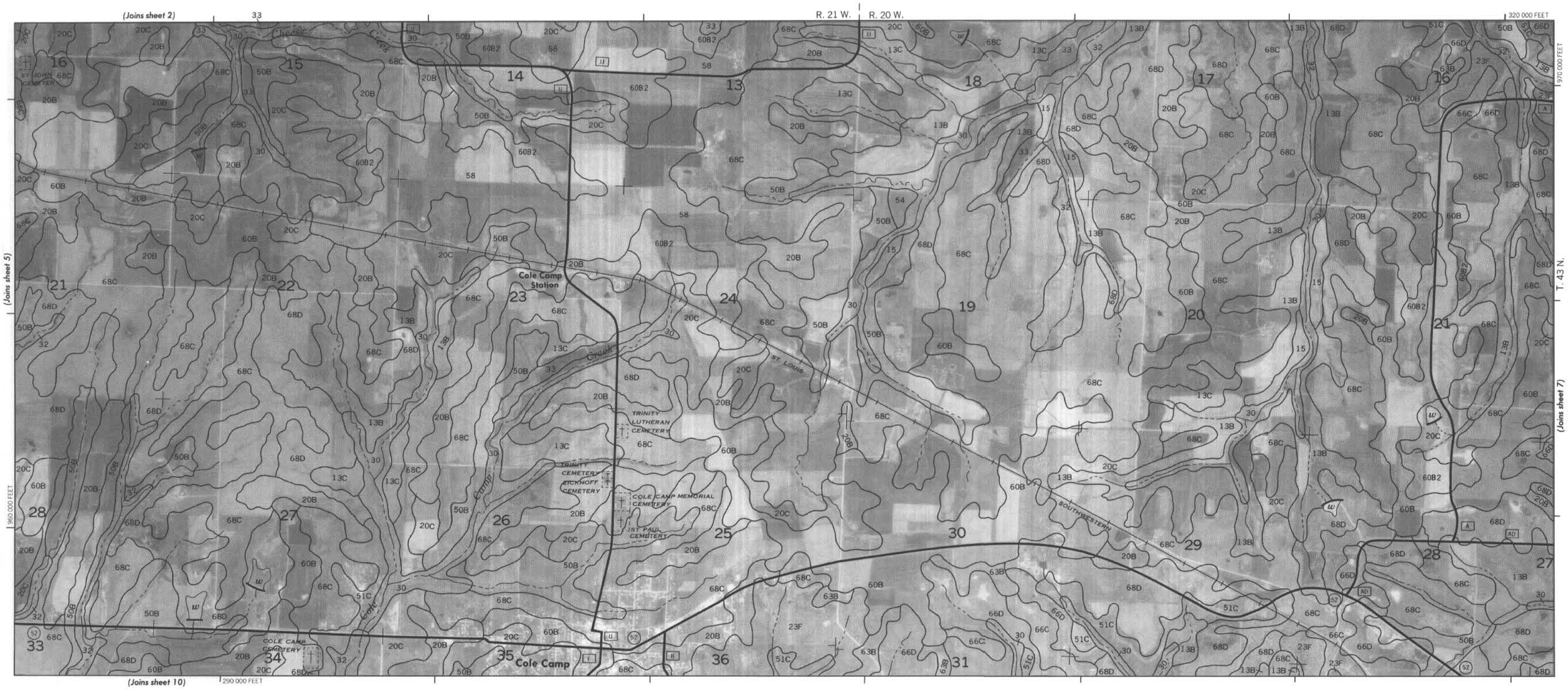

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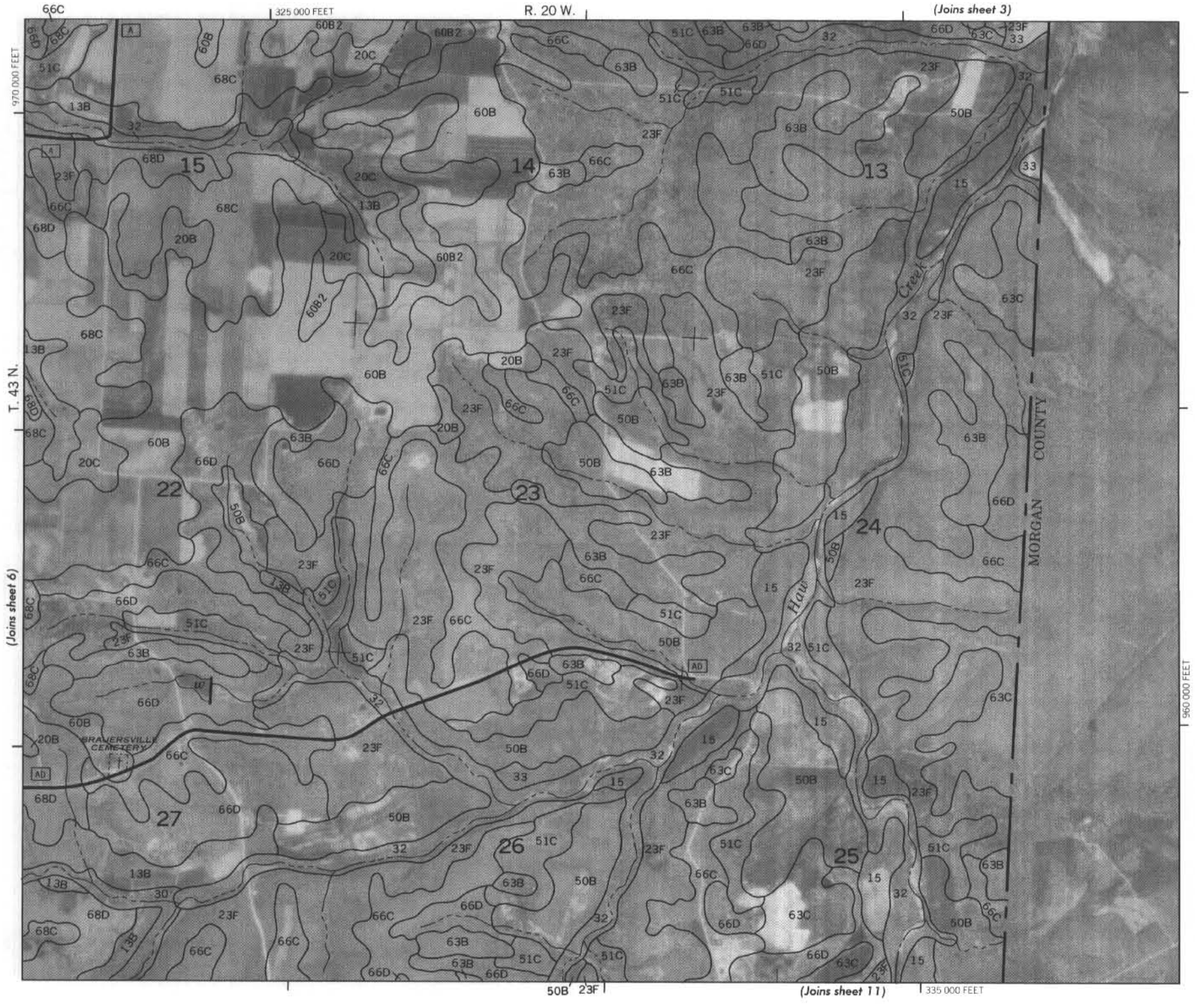

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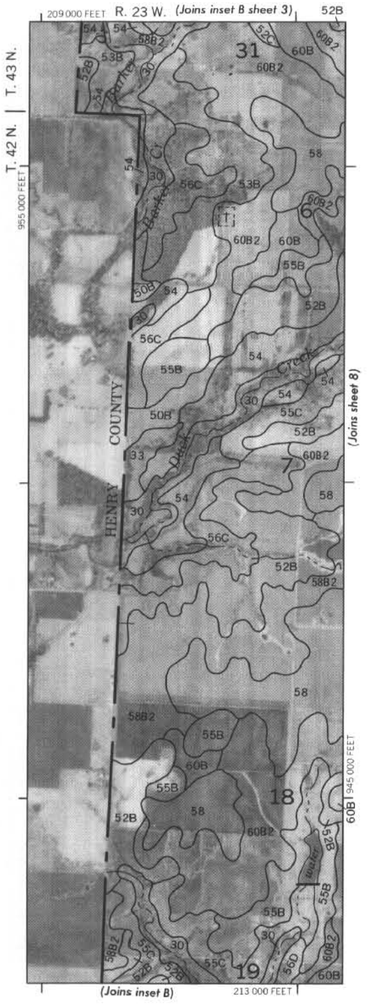

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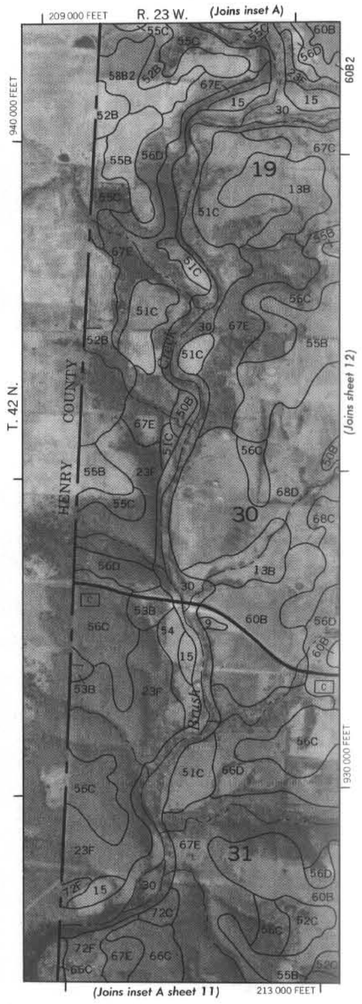
INSET B



4000 AND 5000-FOOT GRID TICKS

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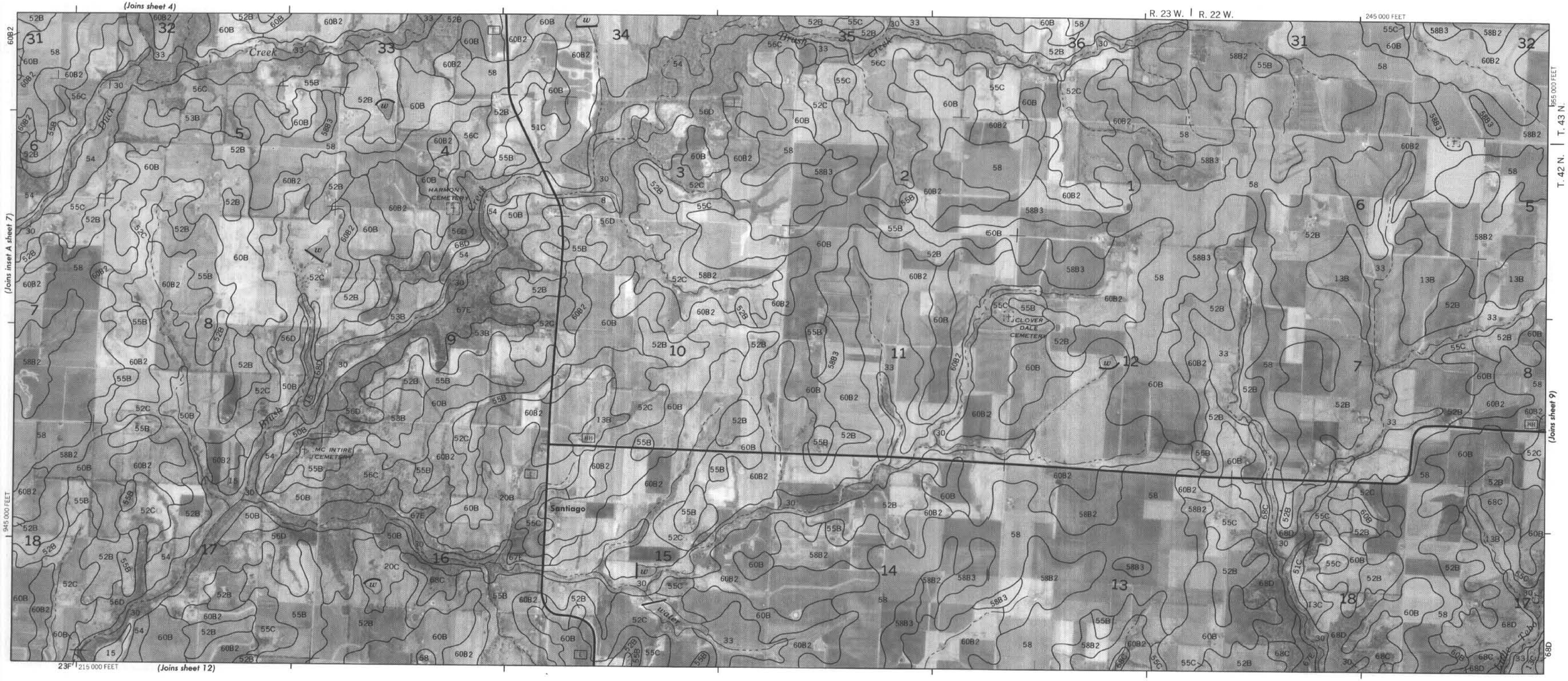

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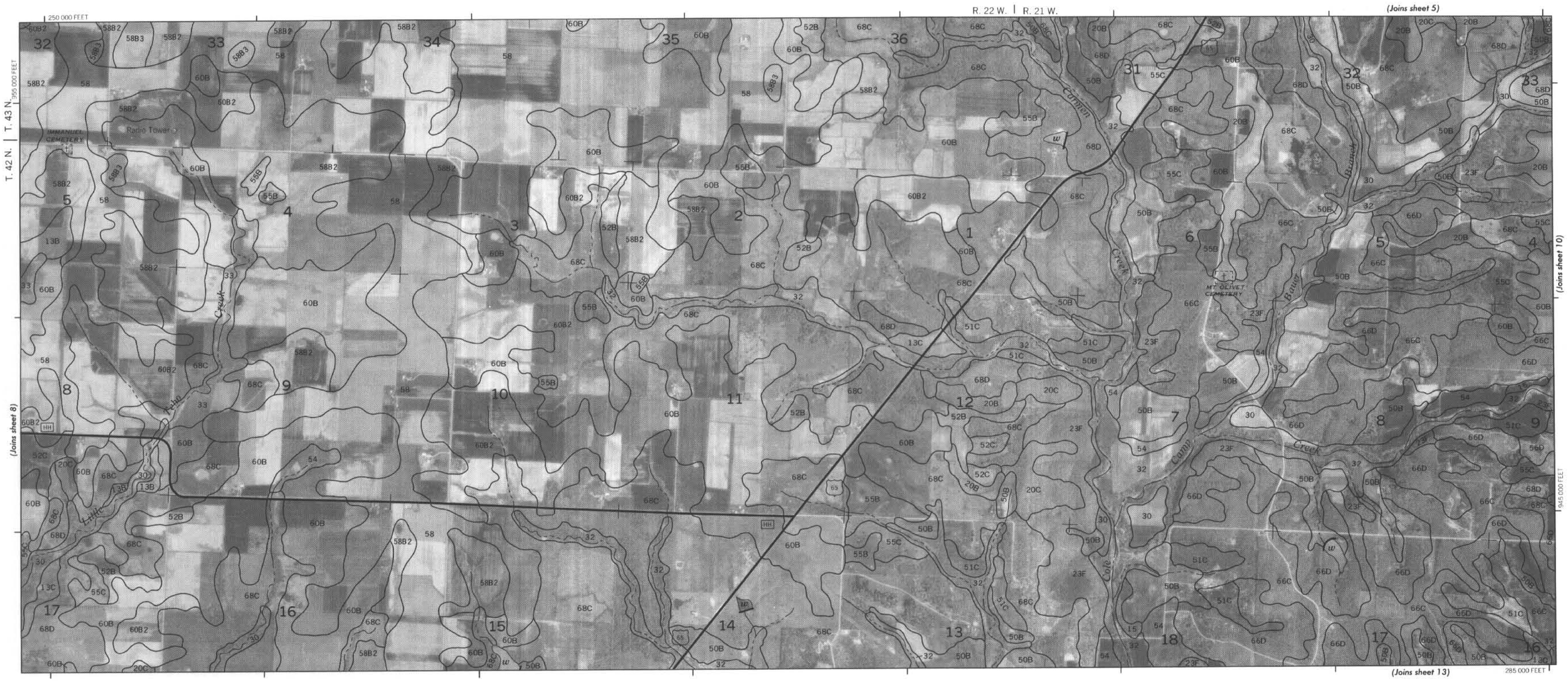

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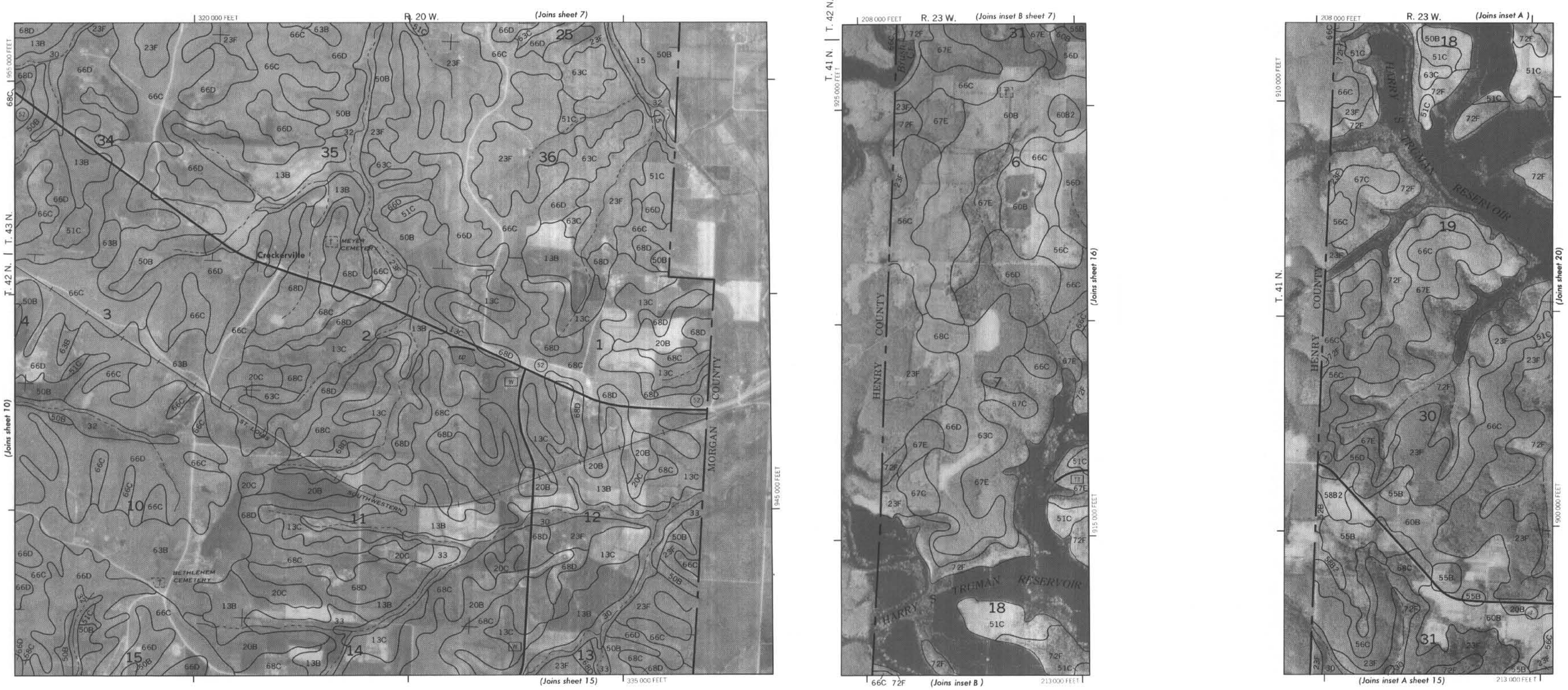
INSET A

INSET B



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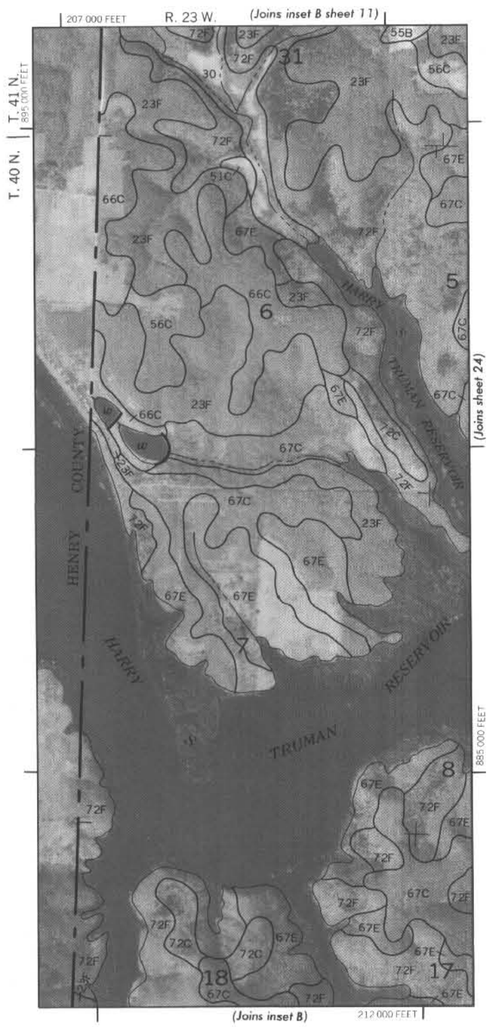

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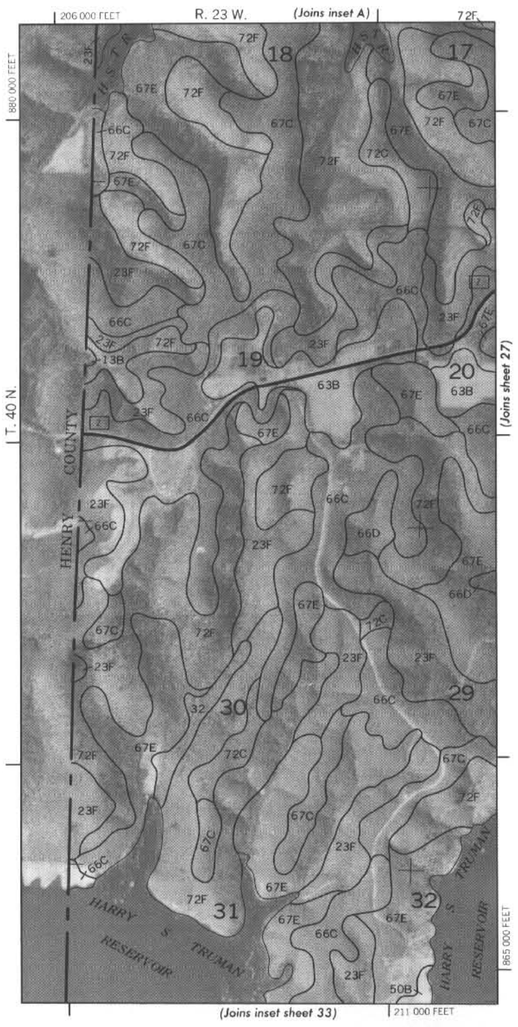

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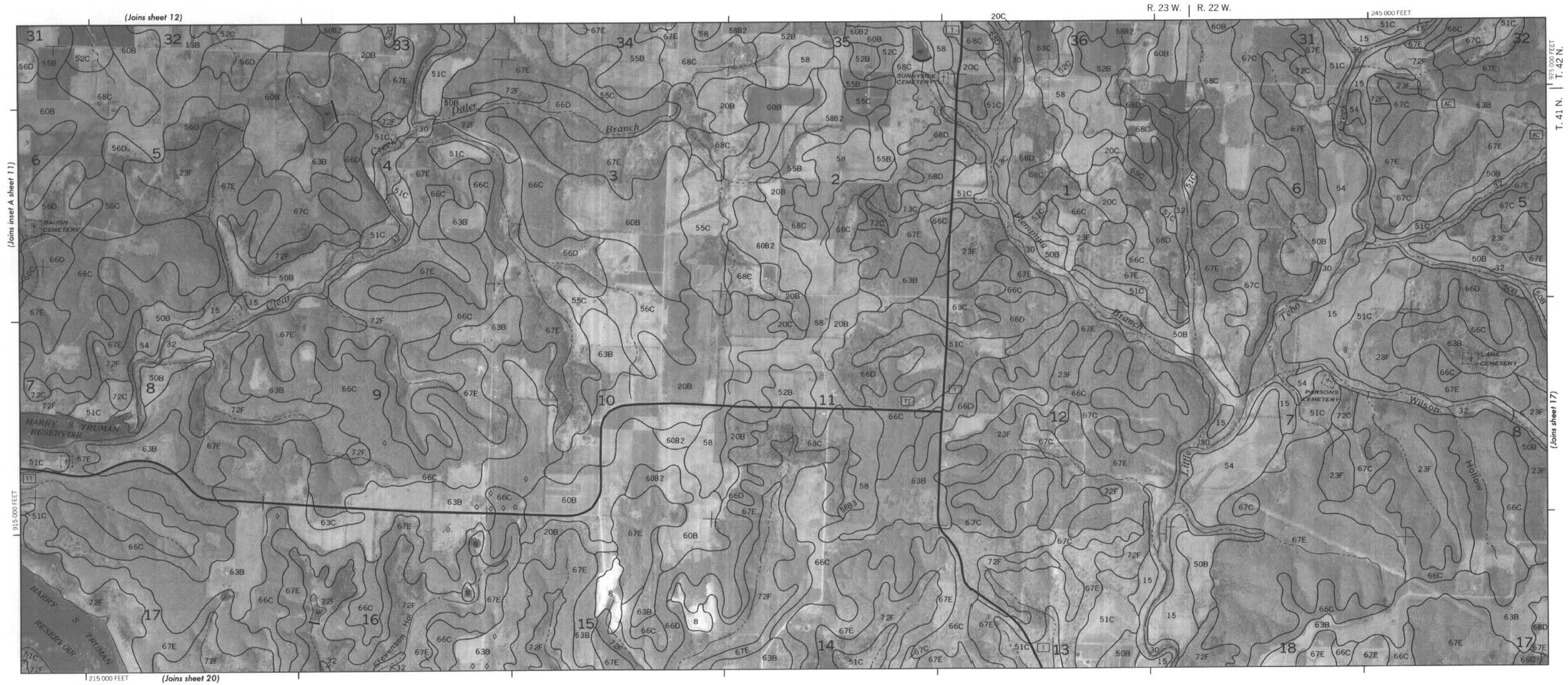

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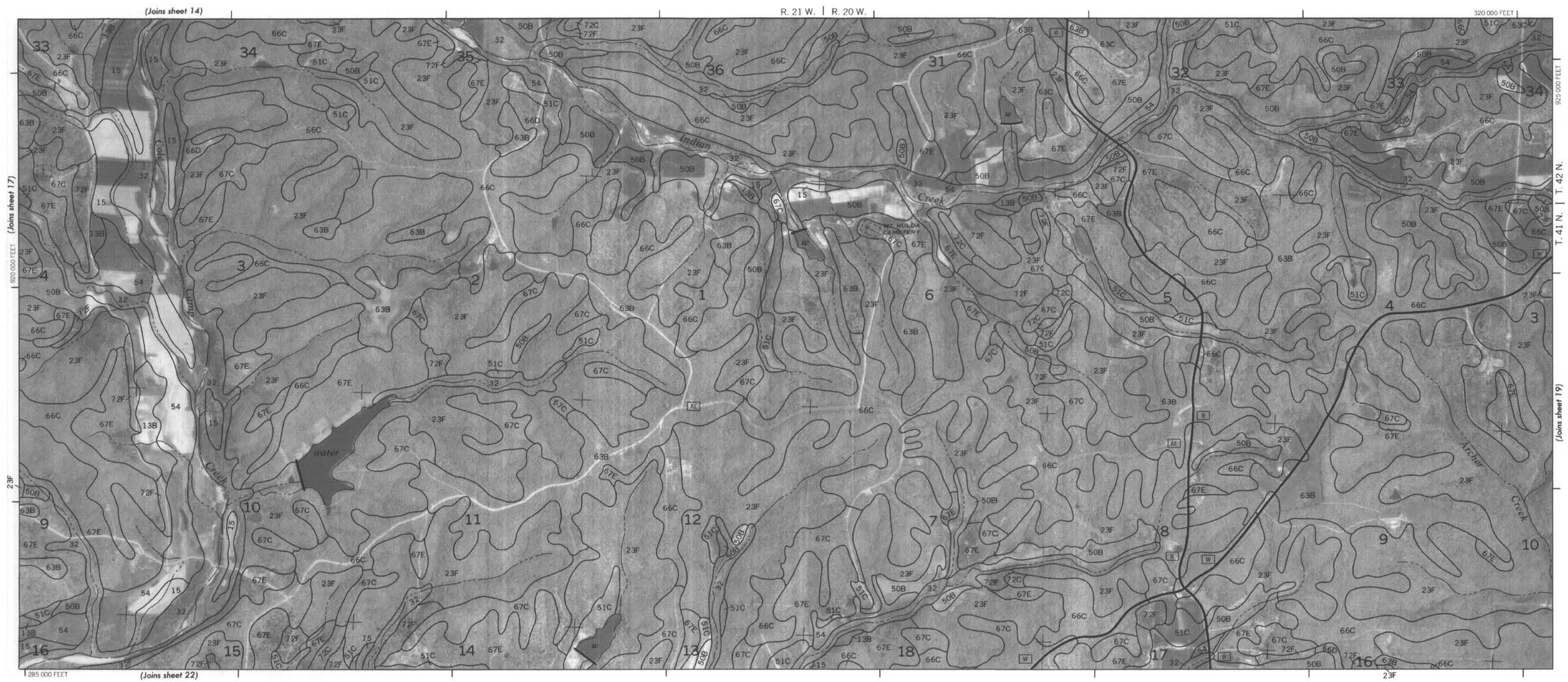

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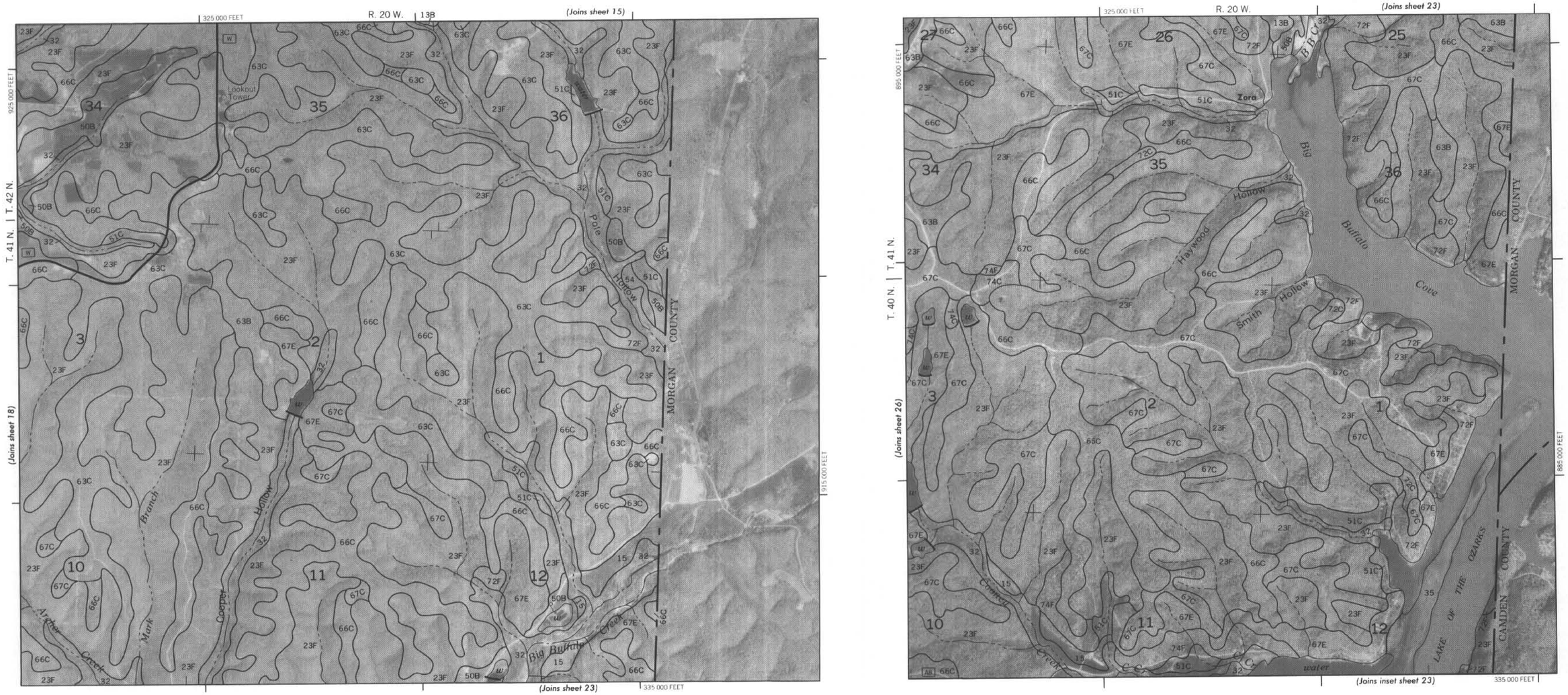

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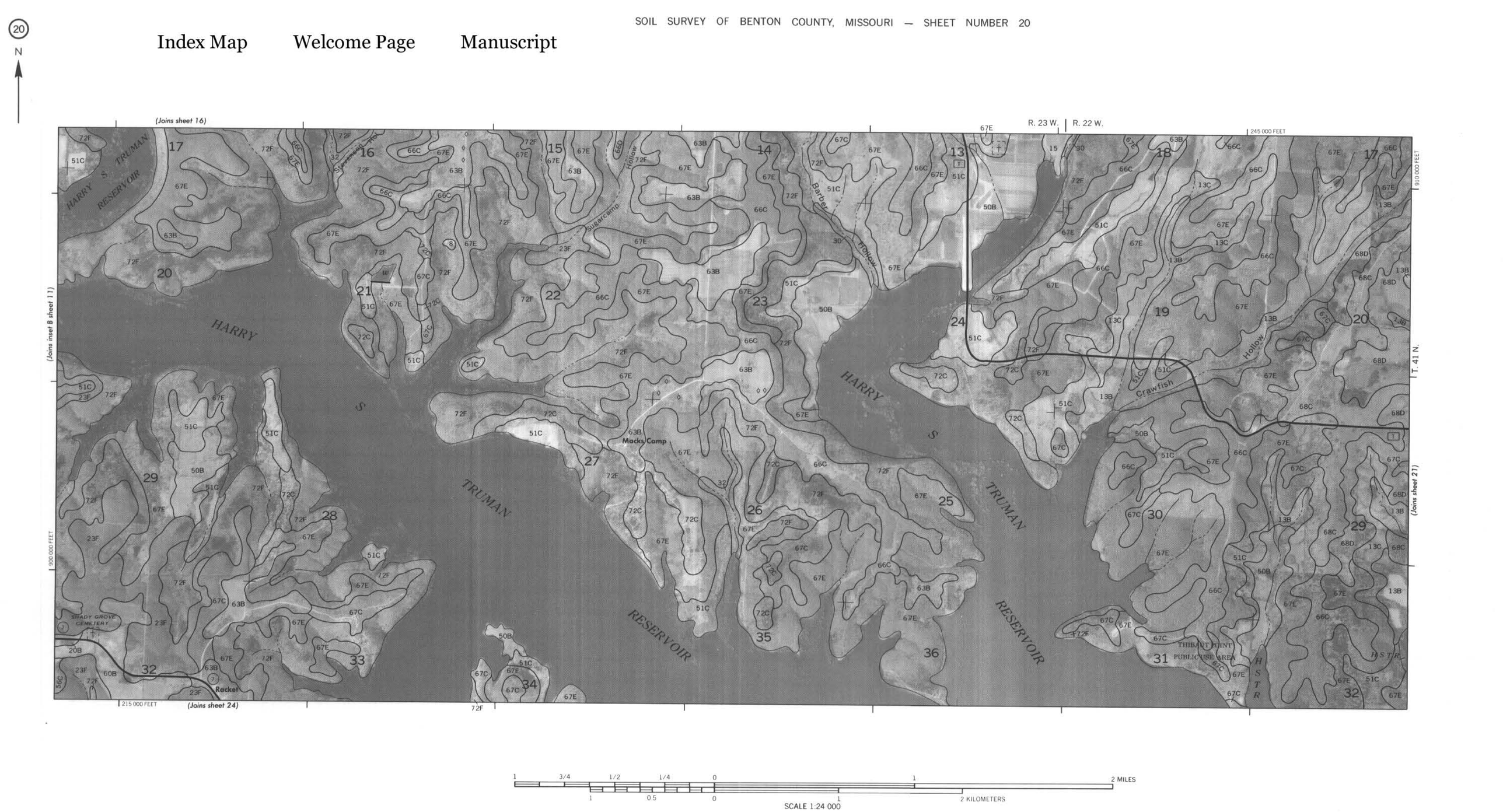

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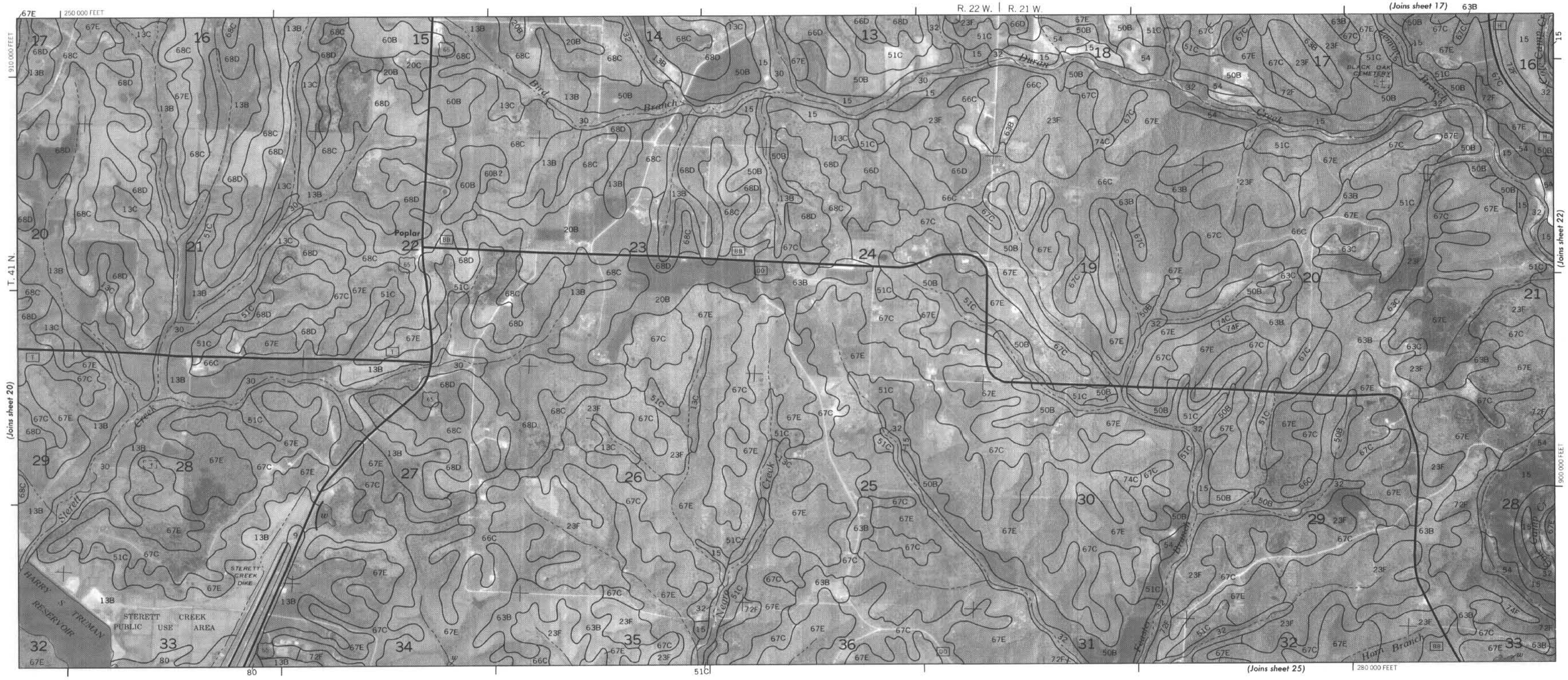

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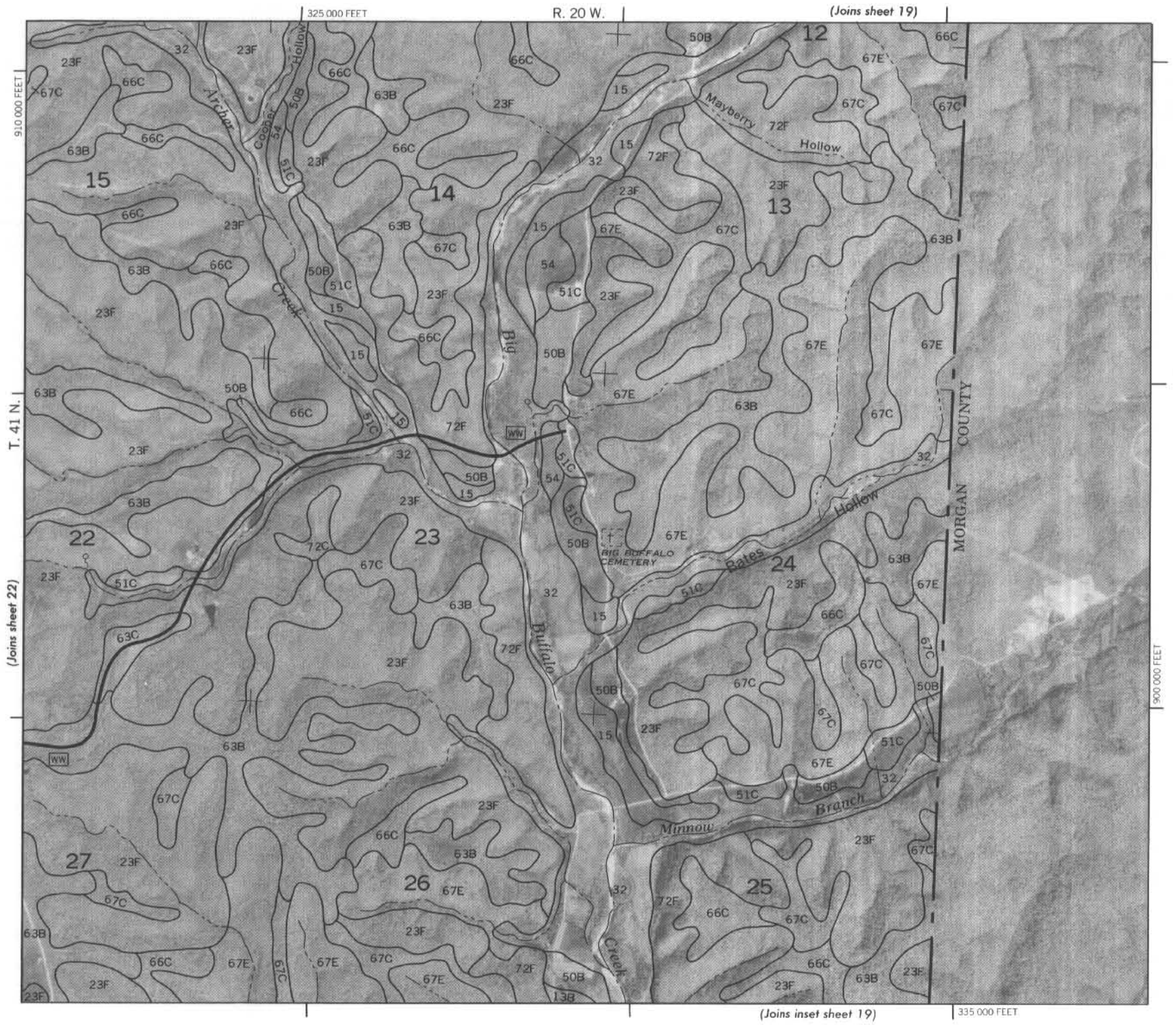

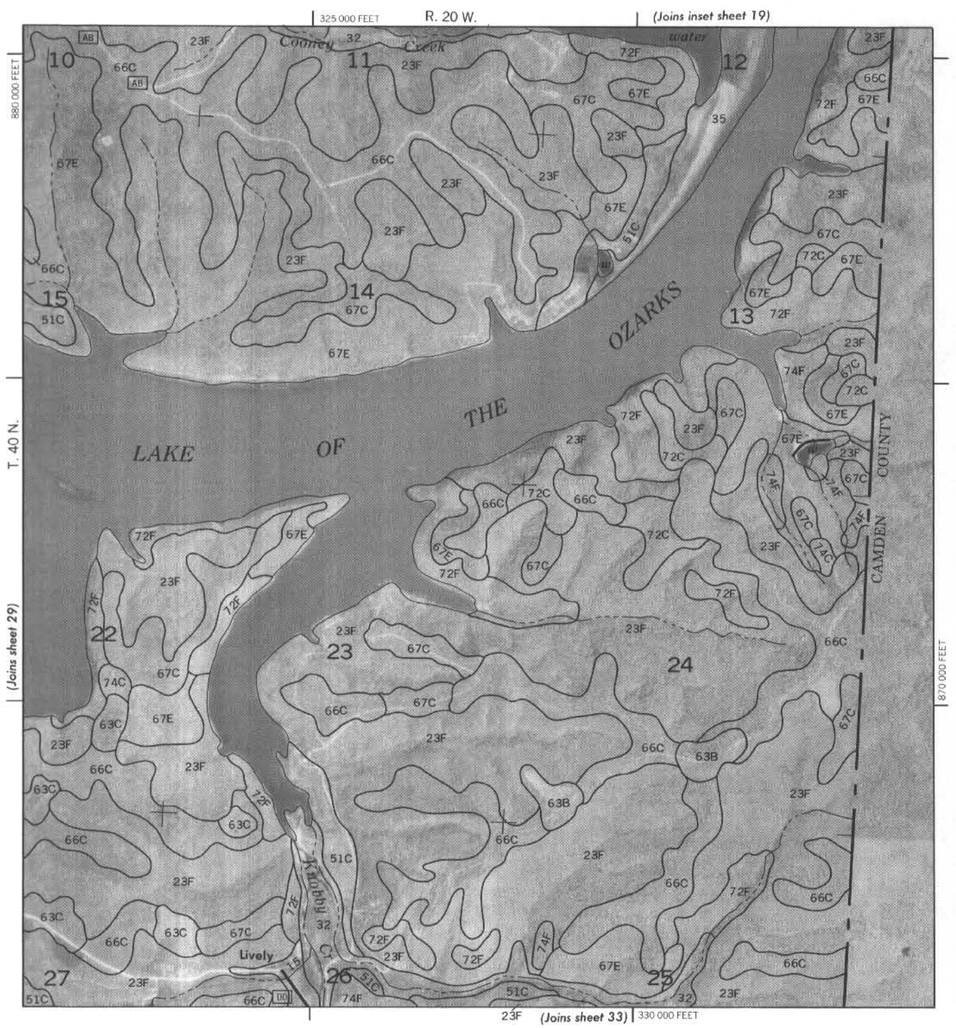

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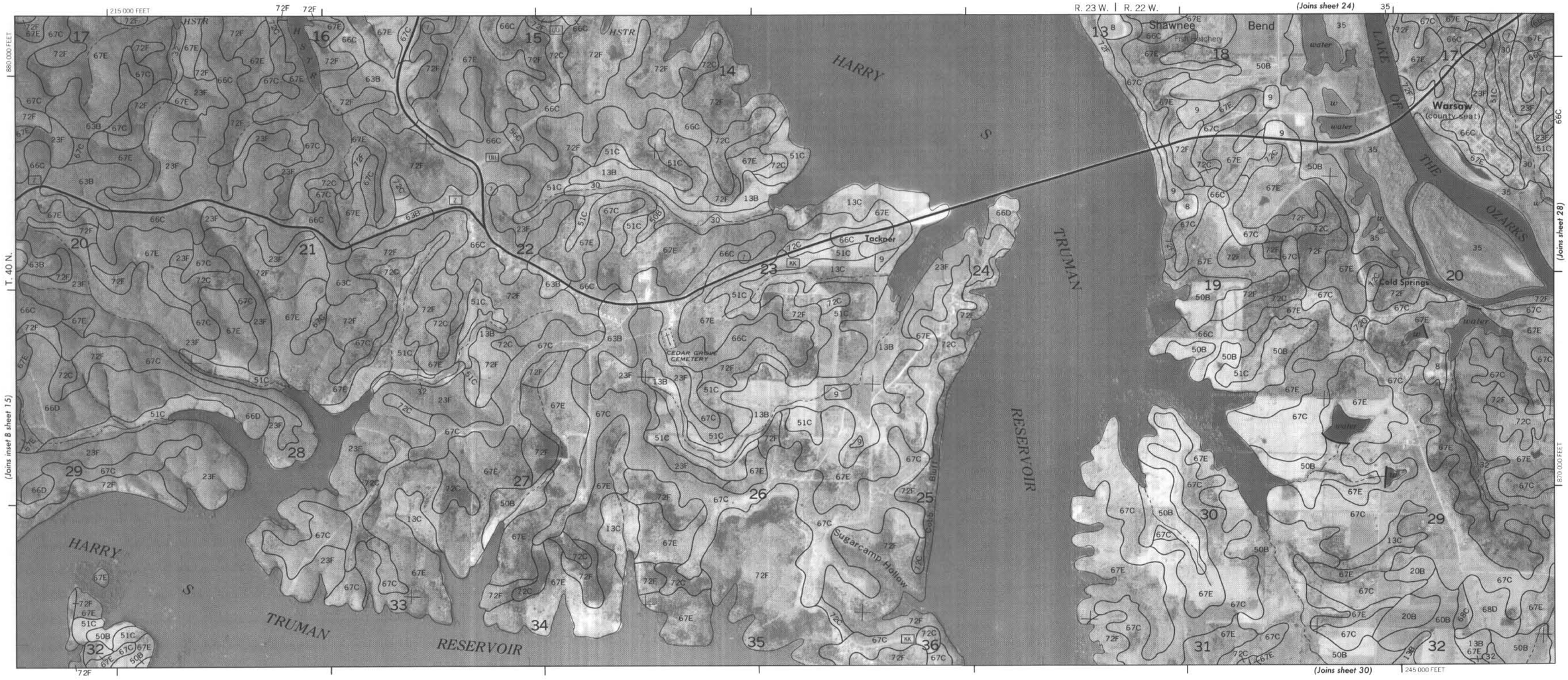

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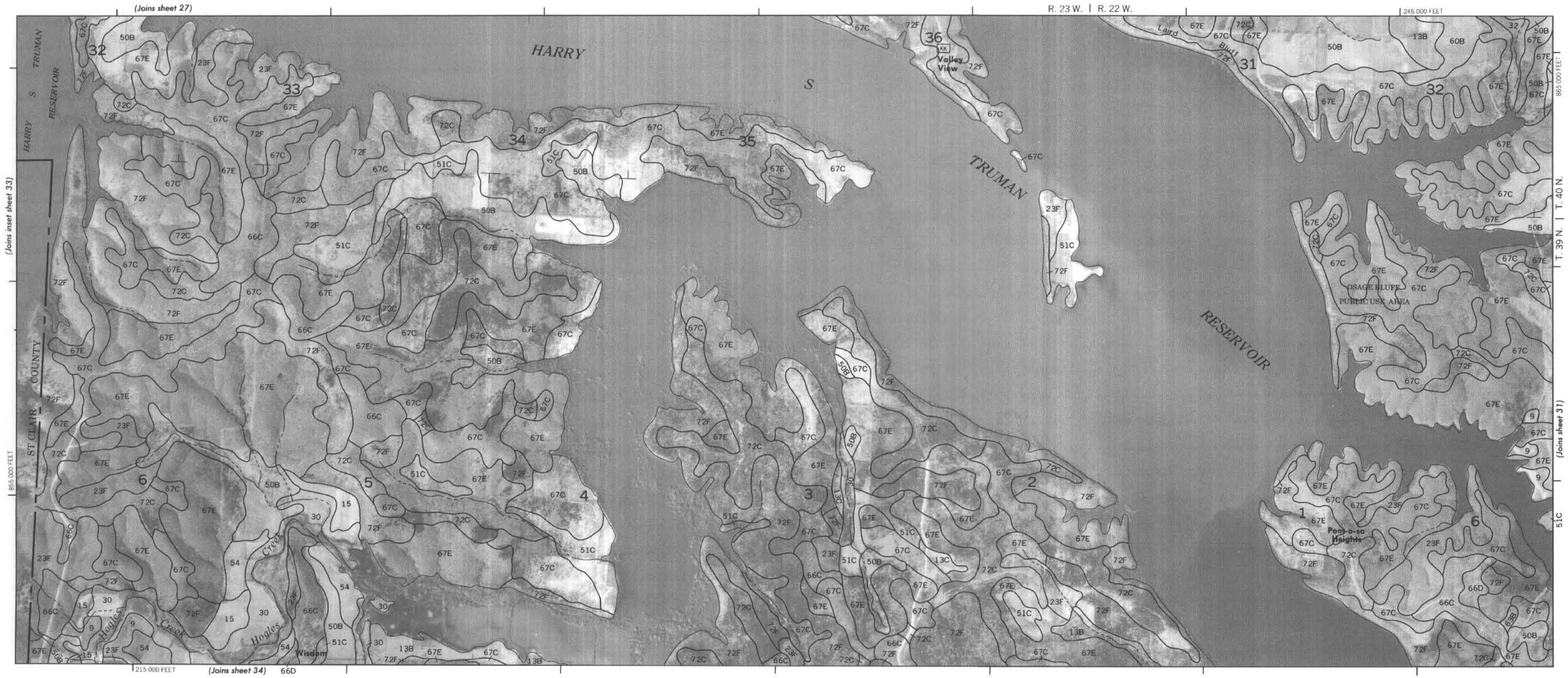

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1 0.5 0 1 2 KILOMETERS
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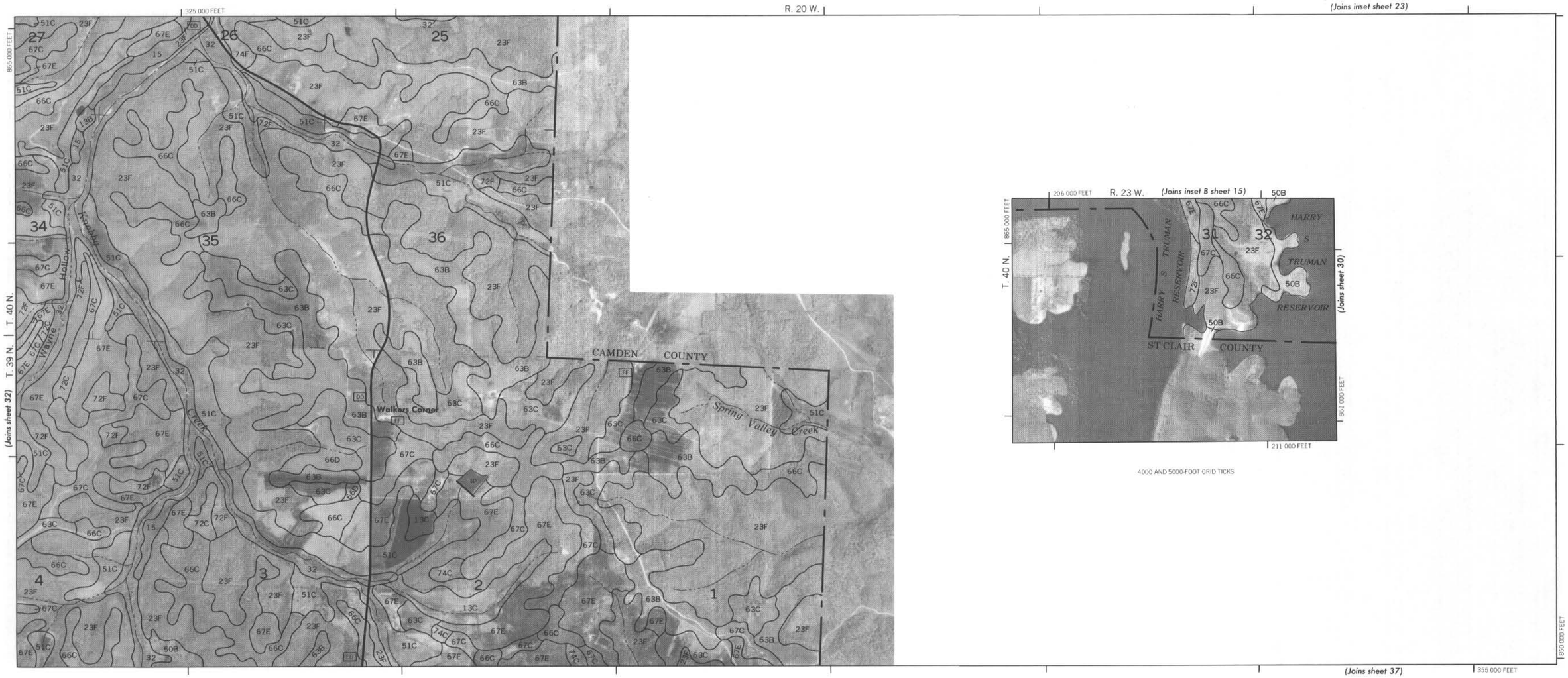

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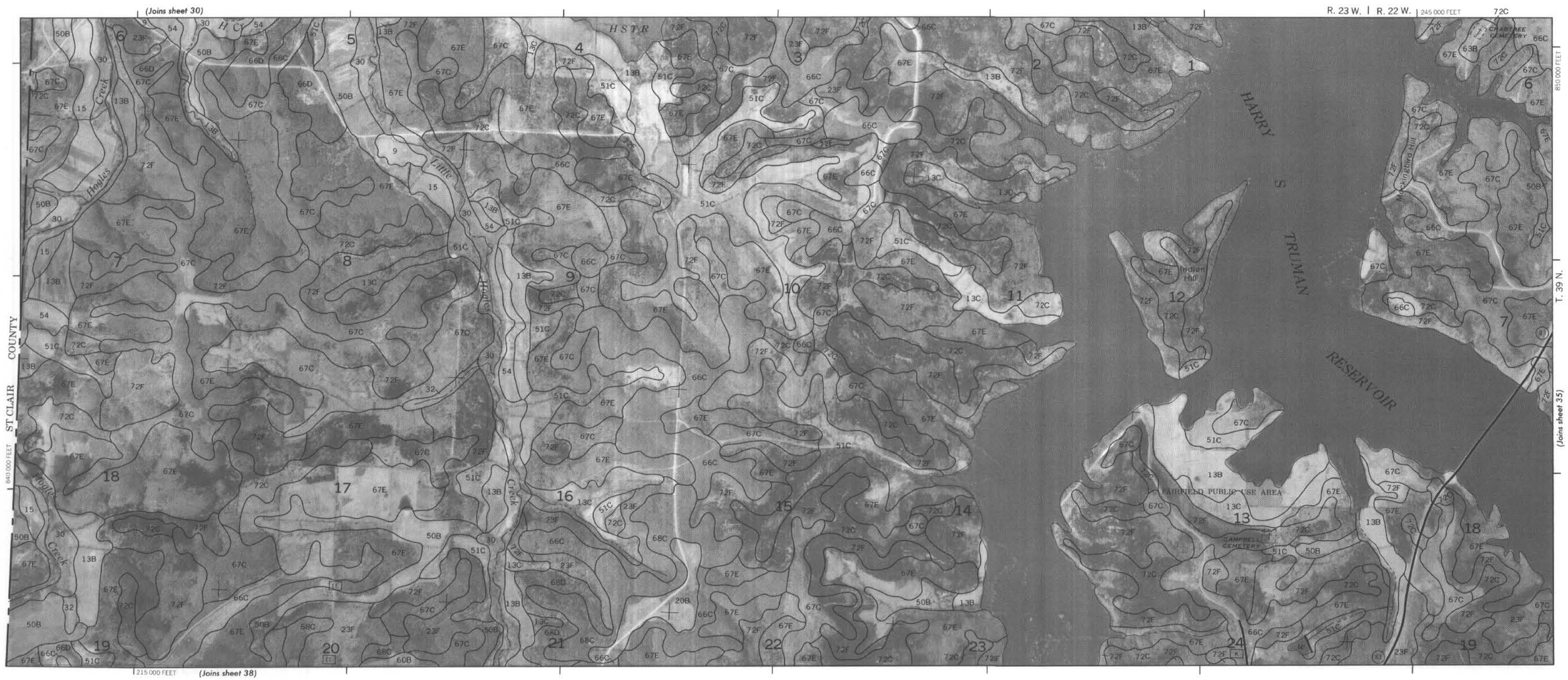

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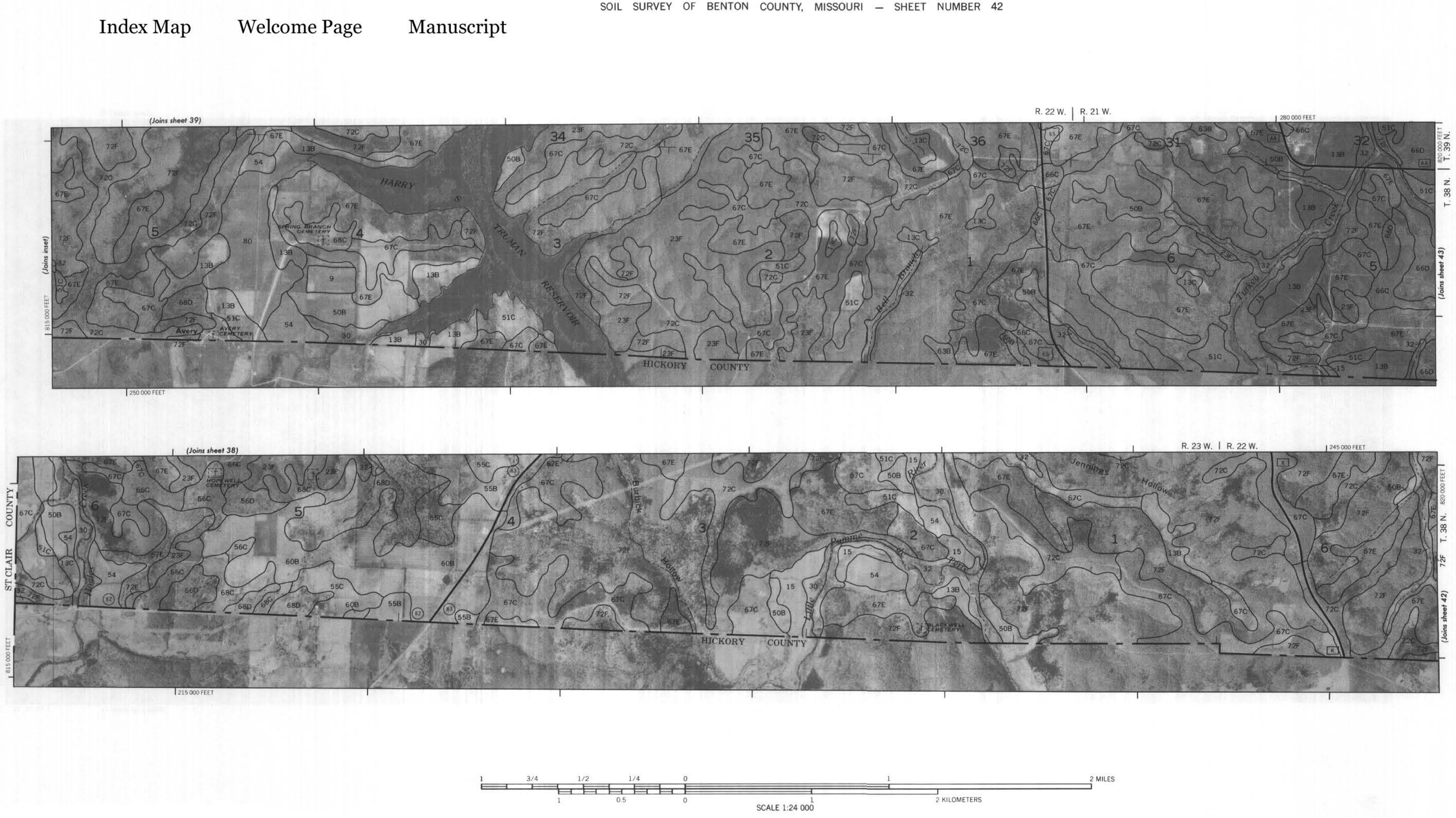

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4000 AND 5000-FOOT GRID TICKS

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